

Montana's Rocky Mountain Front: Vegetation Map and Type Descriptions

Prepared for:

United States Fish and Wildlife Service

By:

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Montana Natural Heritage Program
Natural Resource Information System
Montana State Library

February 2006



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Agreement Number:

1448-60181-02-J555

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This document should be cited as follows:

Kudray, Gregory, M. and Stephen V. Cooper. 2006. Montana's Rocky Mountain Front: Vegetation Map and Type Descriptions. Report to the United States Fish and Wildlife Service. Montana Natural Heritage Program, Helena, Montana. 26 pp. plus appendices.

ABSTRACT/EXECUTIVE SUMMARY

The Montana Rocky Mountain Front is a landscape of national importance, noteworthy for not only its scenic beauty, but also for the high-quality and diverse wetland, prairie, riparian and montane habitats found there in abundance. Planning to conserve habitat on the Front requires a good understanding of what habitats are present and where they occur. The intent of this project is to better classify and map ecosystem types along the Front with a focus on the ecologically important upland grassland communities critical for some declining species of grassland birds and many other animal species. Existing maps were not very detailed or accurate and had mapping units that were not based on ecological habitats. This report, along with an associated map, provides a conservation baseline with mapping types defined ecologically and linked to the information-rich National Vegetation Classification System.

We mapped several grass- and shrub-land types, and described the vegetation associations and ecological setting for each. Three landscapes of particular quality were described and entered into our database. All ecosystems were mapped with a level of detail accurately achievable using the Landsat TM imagery and ancillary data we had available. Over 200 ground observation points helped to verify map accuracy and provide classification training sets. National Wetlands Inventory (NWI) maps were incorporated to provide the most detailed wetland mapping while National Land Cover Data was used to best define agricultural land. Three forested types were distinguished including the rapidly deteriorating and threatened Limber Pine ecosystem.

Grass- and shrub-land types were based on their vegetation cover and associated environmental

characteristics. Fescue grasslands occur in the ecotone between prairie and montane environments with more precipitation than nearby prairie grassland types but less than forested types in higher elevations. Two prairie grassland types were separated based on the dominant vegetation and associated soil texture. An upland shrub type included some relatively unique shrubby cinquefoil and juniper vegetation types; these generally had fescue as the dominant grass.

The wetland and riparian types on the Front are especially diverse, widespread (due to considerable subsurface discharge), and important for habitat. The NWI types were aggregated into six classes; there was also a non-wetland riparian type (non-agricultural) mapped and described. Four NLCD agricultural land types were differentiated in the map.

Mapping accuracy could not be quantitatively determined due to the relatively few ground plots not incorporated into the classification training set. We felt that incorporating these points into the training sets made the map more accurate and was a higher priority than a formal accuracy assessment. However, the accuracy assessment routine we applied indicated where confusion was most likely to occur, e.g. between grassland and shrubland types.

While an accurate map based on ecological types will aid conservation planning, we recommend a landscape scale assessment that will identify areas most important for habitat. This kind of assessment incorporates landscape connectivity, human influences, habitat quality, and habitat arrangement to identify specific conservation priority areas.

ACKNOWLEDGEMENTS

This project was funded by the US Fish and Wildlife Service (USFWS); we especially thank Gary Sullivan for his vision of conservation planning and recognizing the need for this basic resource data to support conservation. Dave Hanna of The Nature Conservancy provided vegetation plots to support this classification as did Tom Miewald of Sanborn Consulting; we thank both of them for making this effort better. Corey Baker of Gradient Consulting did a great job helping with technical issues. We'd also like to thank Allan Cox and Coburn Currier of the Montana Natural Heritage Program for GIS technical/cartographic support and publishing this report, respectively.

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INTRODUCTION

The United States Fish and Wildlife Service (USFWS) recognizes the Rocky Mountain Front in Montana as one of the nation's most significant wildlife areas (USFWS 2005). As defined for this project, the Front includes the transition zone between the Rocky Mountains and the mixed grass prairie in northwest Montana and encompasses a wide variety of wetland, riparian, grassland, and forested habitats. Grizzly bears still venture down into these grassland habitats in the spring and virtually all other presettlement plants and animals (except the bison) are still present. Migratory waterfowl use the abundant wetlands found along the Front and the diverse mix of habitats supports many species of conservation concern. To help conserve this important habitat the USFWS has implemented a voluntary, incentive-based easement program to conserve wildlife habitat on private land through the purchase of conservation easements (USFWS 2005).

Conservation planning depends on an accurate map of the type and location of habitats in an area. Existing mapping of the Front includes two products that are part of a nationwide large-scale land mapping effort. The National Land Cover Database (NLCD) was developed with satellite imagery from the 1990's and has a mapping legend that distinguished only broad types like grassland, shrubland or evergreen forests. Also available is the Gap Analysis Project (GAP) mapping, another 1990's dataset based primarily on satellite imagery. GAP cover types were more detailed but accuracy averaged only 61% and grassland types were based on total vegetation cover rather than species composition or other ecological characteristics. The intent of this project is to better classify and map ecosystem types along the Front with a focus on the ecologically important upland grassland communities critical for some declining species of grassland birds and many other animal species.

Mapping is most useful when classification types are related to controlling ecological factors, which also correlate to species habitat. New GAP mapping projects underway use the Ecological Systems classification developed by NatureServe, a

classification based on multiple factors including vegetation, environmental factors, and disturbance regime. These mapping units can be used with the rest of the National Vegetation Classification System hierarchy to create a mapping system applicable at a variety of scales. Another advantage of this classification hierarchy is the rich detail of information available about the vegetation and ecology of these classification units. Resource managers can apply this information with the spatial representation of mapping units to create a detailed analysis of habitat potential in a landscape.

STUDY AREA

Geology

The study area (Figure 1) lies at the eastern edge of the Rocky Mountains where tectonic plates collided and pushed large slabs of rock upward in a fold-and-thrust belt. The following strata descriptions correlate to Figure 2, depicting statewide geology coverage based on USGS 1955 data and available in digital form from the Montana Natural Resources Information System. The highest elevation landforms are located in the most western section of our study area and are mapped as Paleozoic era sedimentary rock composed of sandstone, shale, and limestone (including dolomite). The Kootenai Formation from the Mesozoic era is found adjacent at lower elevations and is also sedimentary rock but composed of conglomerate, sandstone, shale and mudstone. The Colorado Shale Formation of shale and siltstone is typically found at the next lowest topographic position. At lower elevations alluvial deposits are common with layers of gravel, sand and silt. There are also significant low elevation glacial deposits from the Pleistocene age that have variable, mostly coarse textures. The Two Medicine Formation from the Cretaceous era is one of the most common lower elevation types and is sedimentary with clay, limestone, and sandstone. There is also a prominent area of Cretaceous volcanic rock in the far southern part of the study area.

Climate

The climate here is generally cool and dry but there is considerable variability corresponding to the east

– west elevational gradient that greatly influences vegetation and habitat. The weather station at the Gibson reservoir near the western extreme of our boundary has above freezing average maximum temperatures all year with the coldest minimum temperatures in January (12.4° F). July and August are the warmest months with an average high around 77° F and a low near 45° F. The Augusta climatic station at the eastern boundary of the study area has similar above freezing winter average maximums but is colder at night with January average minimums of 10° F. Average summer temperatures are also warmer in Augusta with July and August maximums slightly over 80° F and minimums around 47° F.

Gibson Dam receives almost 18” of precipitation annually; May and June are the wettest months with about 3” per month; all of the winter months receive less than 1” of precipitation per month. Augusta has a similar pattern with relatively wet springs and dry winters although the total precipitation annually averages only about 14”. This precipitation gradient (along with soils) is key in structuring vegetation communities across the Front. This summary is from the Western Regional Climate Center (2005).

General Vegetation Description

The landscape is extremely variable and extends from higher elevation barren rock or forested stands of Douglas-fir (*Pseudotsuga menziesii*) or aspen (*Populus tremuloides*) to mid-elevation limber pine (*Pinus flexilis*) woodlands down to a complex mosaic of mixed-grass prairie with agricultural grain and hay fields at lower elevations and in floodplains. Higher elevations also include fescue (*Festuca* spp.) grasslands and a large acreage recovering from a wildfire that is now a mix of mostly Douglas-fir regeneration among burned tree trunks over relatively lush fescue grasslands. The fescue is often mixed with shrubs; creeping juniper (*Juniperus horizontalis*) and kinnikinnick (*Arctostaphylos uva-ursi*) occur on somewhat drier sites while shrubby cinquefoil (*Dasiphora floribunda*) is common in more mesic areas resulting from aspect or moisture run-in. Shrubby cinquefoil is particularly common in the

northern extreme of our study area but also follows the greater eastward expansion of the fescue type in the southern end, where it is more closely associated with stream terraces. The aspen stands are typically small clonal patches in landforms that receive some additional moisture or have a more mesic aspect. Limber pine stands are generally in decline, primarily from white pine blister rust disease. Dead and dying trees are typical; some former stands can only be recognized by the dead tree trunks.

The riparian strips associated with the larger drainage system are especially diverse and rich in habitat value. Natural vegetation communities generally correspond to the height of the floodplain above the water table although successional influences also affect the distribution of shrubby and forested types – early shrub establishment can give way to later forested stands on suitable sites. The shrub communities also respond to a moisture gradient; willows (*Salix* spp.) and red-osier dogwood (*Cornus sericea*) dominate the wetter sites while chokecherry (*Prunus virginiana*), Saskatoon serviceberry (*Amelanchier alnifolia*), and Woods’ rose (*Rosa woodsii*) occur on drier sites, sometimes with an aspen overstory. Wet meadows dominate riparian areas where water tables are high and there is not sufficient water movement to oxygenate the soil enough for shrubs and trees. Flood irrigated hay meadows are also common where the floodplain is wider and soils are suitable.

The fescue grasslands at higher elevation (and correspondingly greater precipitation) transition at lower elevations to grasslands dominated by various grass species in response to soil and topography. Western wheatgrass (*Pascopyrum smithii*) is the dominant species in swales or topographically lower landforms with heavier soils and often moisture run-in. Needle and thread (*Hesperostipa comata*) is the most common species on sandier soils, which tend to occur somewhat higher in the local landscape. Bluebunch (*Pseudoroegneria spicata*) is associated with steeper slopes; mixtures of any or all these grasses can occur with the variable conditions found in this diverse landscape. Blue

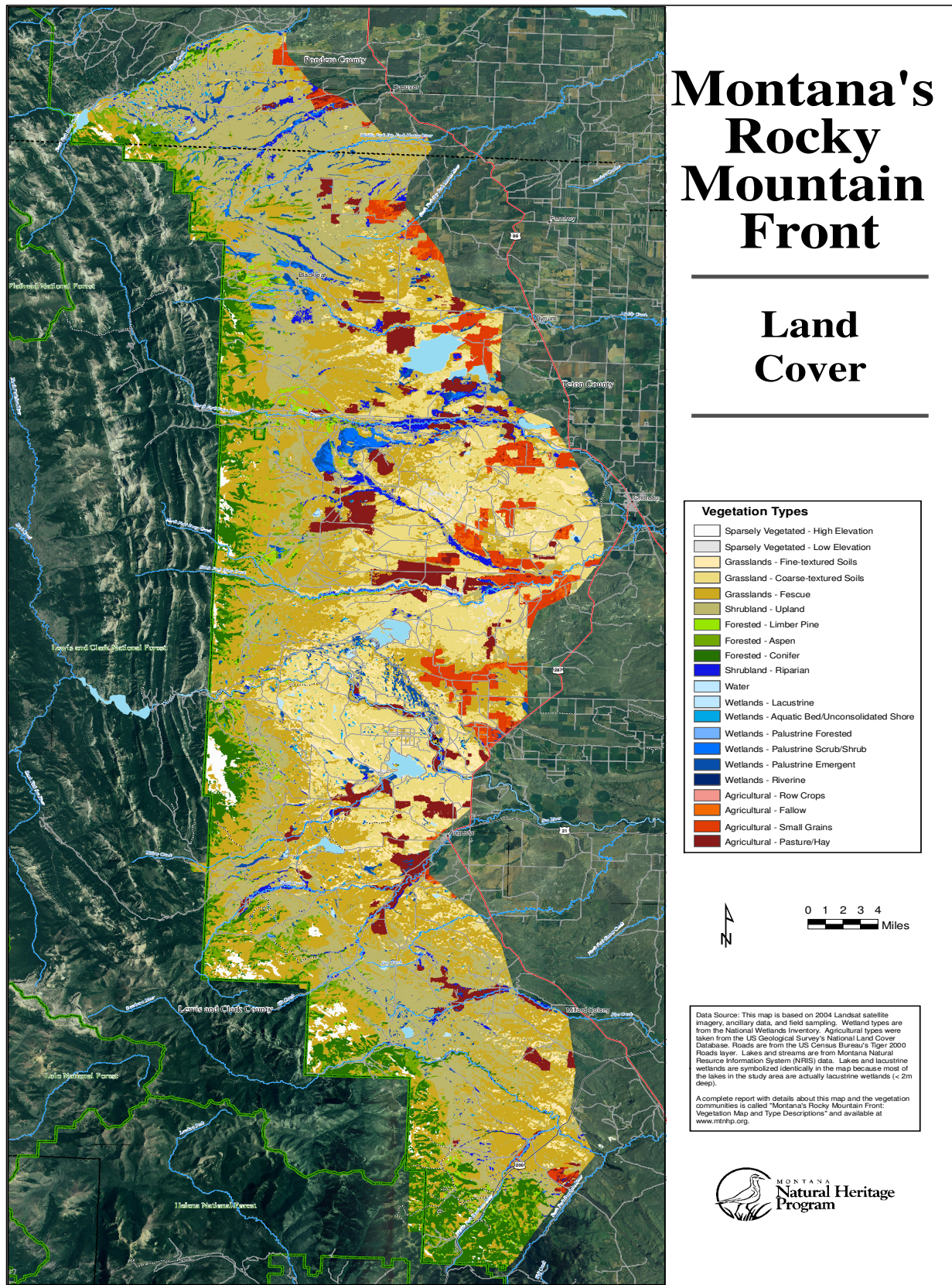


Figure 1. Study Area Map.

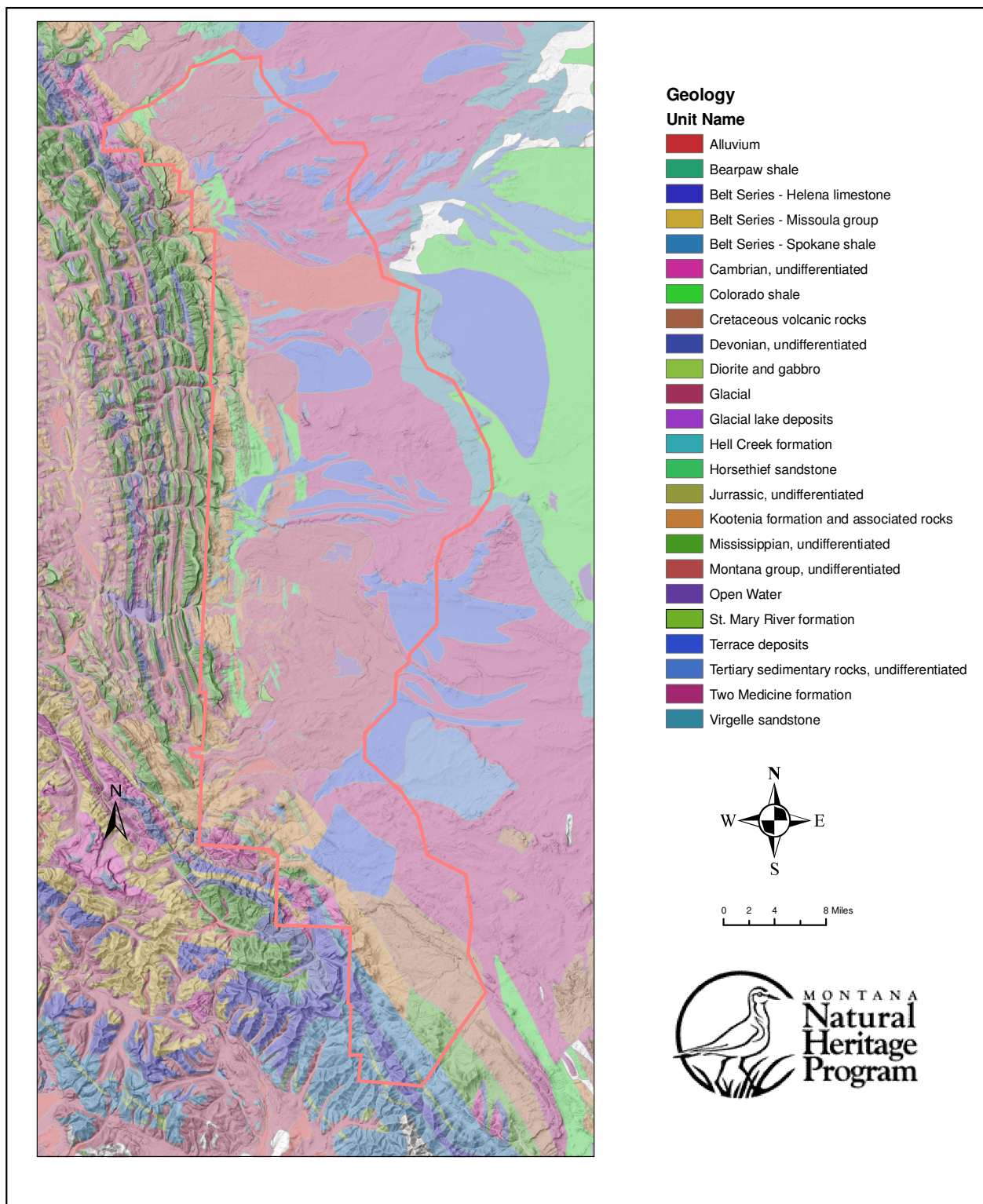


Figure 2. Study Area Geologic Map.

grama (*Bouteloua gracilis*) can become very common with sustained heavy grazing. The absence of sagebrush is notable and currently unexplained.

A variety of wetland types occurs throughout the upland matrix in pothole depressions, larger shallow basins, or swales with impeded drainage. There is considerable diversity; some basins dry to bare soil after seasonal flooding while others will have a variety of wetland types in a zoned pattern dependent on seasonal water table depths and salt concentrations. Most of these areas are graminoid dominated but shrubby cinquefoil is common in swales. Willows may be found but are much more common in riparian wetlands.

Agricultural fields are most common in the central part of the study area. In addition to flood irrigated hay fields, there are some central pivot irrigated hay fields and dryland small grain production. Barley and wheat are the typical dryland crops but some fields have been planted to a variety of introduced species and are used for grazing land or hay production. Although a somewhat uncommon practice, fields have also been planted back to cultivars (presumed) of native species (mostly western wheatgrass) and can be identified by their unusual degree of uniformity, lack of forb diversity and telltale furrowing.

METHODS

Field Sampling Methods

Field sampling consisted of two methods that varied in vegetation sampling intensity. We used standard Montana Natural Heritage Program (MTNHP) community ecology comprehensive sampling techniques to sample 61 plots. These plots include abiotic data and vegetation composition and cover at various height strata. This sampling focused on grassland vegetation types that were representative of the spectrum of variability within each type. An additional 101 rapid assessment plots were used to compile a larger number of locations for use as training data in the remote sensing classification process. These plots were variable in intensity; all had location data recorded with a GPS and a mapping type listed but vegetation data varied from

fairly complete species lists to only a record of dominant species. Sites were selected that represented typical vegetation types and were relatively uniform throughout as large an area as possible for better remote sensing training data. All plot data was recorded during the summer and fall of 2005 and has been entered into the MTNHP database.

Mapping Methods

The mapping process involved processing spatial data with Erdas Imagine 8.7 software then applying Rulequest See5 classification and regression tree (CART) software in conjunction with a US Geological Survey NLCD classification tool to develop a land cover map of the study area. There were several steps in the process.

Spatial Data Preparation

Pixels 30 m X 30 m were the standard size used for all spatial data. A Landsat Thematic Mapper (TM) image from July 16, 2004 was the spectral data source used in the classification procedure. The Landsat TM sensor records seven bands of spectral data in the visible, infrared, and thermal portions of the electromagnetic spectrum. The spatial resolution of this sensor is 30 m (the 60 m thermal band-6 was resampled to 30 m using nearest neighbor interpolation), resulting in a 900m² (0.09 ha) minimum mapping unit.

We corrected the scene to at-sensor reflectance using the United States Geological Survey (USGS) equation (Huang et al. 2001), USGS Landsat TM gain/bias values, and solar elevation data from the metadata file. The at-sensor reflectance values are calibrated to adjust for sun angle, earth-sun distance, solar irradiance, and instrument noise (Huang et al., 2001; Huang et al., 2002).

These values were used to calculate the Tasseled Cap (TC) transformation. This transformation is used as a predictable method for compressing scene characteristics into three orthogonal spectral bands (Huang et al. 2002). TC transformations produce reliable spectral bands that can be directly associated with physical scene characteristics. TC-Component 1 is a measure of brightness, TC-

Component 2 is a measure of greenness, and TC-Component 3 is a measure of wetness. The brightness, greenness, and wetness components generally account for over 97% of spectral variability present in a given scene (Huang et al., 2002).

Digital elevation data was used directly and to derive slope and aspect layers. We created slope data with a model in Imagine. The Imagine aspect model was modified to code each pixel into one of eight possible aspect categories. We combined National Wetlands Inventory (NWI) quad data for the study area although there were a few quads that weren't available. These areas had minimal wetlands. We converted the NWI data into 30m raster data and used it as a mask to remove these areas from the CART analysis. Similarly, land classified as agricultural in the National Land Cover data layer was also removed. Both of these data sets were then mosaiced back into the final map product. This was done because of the superiority of these data sets compared to the CART classification and the confusion that these complex types created in the CART analysis. We combined Natural Resource Conservation Service SSURGO digital soil data from the three counties that intersected the study area and coded map unit polygons with the component ecological site type that comprised the majority of the map unit. Polygons of similar ecological site type were combined and the data converted to a raster layer. A total of 14 data layers were available for the CART analysis including the elevation derived products, soil data, and 10 bands of TM data (seven standard bands and three tasseled cap bands).

Training Set Development

The location of each plot was viewed with TM imagery and digital orthophotos as background images so that a uniform area could be digitized as a training area for the CART model. Many plots were not used because of site variability or because the vegetation composition of a plot was not clearly attributable to a mapping type. Individual training sites were aggregated to form a training set for each mapping type. The training sets for some mapping types, like water and high

altitude rock that were clearly definable on the images and not visited in person were digitized from the imagery.

CART Modeling

CART is a non-parametric technique that does not assume normal distributions in the available datasets. CART forms dichotomous decision trees using continuous or categorical data (Lawrence et al. 2004). Splits are applied to the classification of an image through classification rules (Lawrence and Wright 2001). Combinations of multispectral and ancillary data have been used in decision trees to produce highly accurate land cover classifications. Decision trees are easily interpreted and can provide valuable insight into ecological conditions.

See5 data mining software uses boosting techniques known as bagging, which uses random subsets of the data to develop decision trees, and boosting, which uses errors in trees to refine new trees. Using a steepest gradient boosting algorithm, the most readily corrected classification problems are emphasized in iterations of tree development and the resulting collection of trees (a grove) vote on the correct classification using a plurality rule (Lawrence et al., 2004).

Development of the land cover map was an iterative process. Training sets and data layers were modified after the accuracy of various types was evaluated with field knowledge and orthophoto imagery. I removed soil data from the analysis because it dominated initial splits in the CART and produced inaccurate results. Agricultural lands included irrigated areas that caused confusion with wetland types, fallow fields that were confused with bare ground, and grain crops that were difficult to separate from native grasslands. Integrating the NLCD agricultural land data into the final map and removing those lands from the analysis was deemed to be the most accurate solution. In some model runs a specific mapping type might be over represented or confused with another type so the training set was modified by eliminating or adding training areas until better accuracy was achieved. The final mapping types were also refined during the modeling process to

achieve a successful balance between accuracy and mapping resolution. We started with more detailed mapping types then aggregated these into broader types when necessary.

A neighborhood model run on the final map in Imagine using a 3 pixel by 3 pixel moving window recoded isolated pixels to the majority type within the window.

Accuracy Assessment

Points with vegetation information from Dave Hanna at The Nature Conservancy and Tom Mieward at Sanborn Consulting were coded to mapping type and combined with MTNHP points that were not used in training sets. The accuracy assessment module of Imagine software was used to run the assessment. The incorrectly assigned points were also attributed to specific mapping types so that type confusion was apparent for each individual type. Even after obtaining plots from outside sources, some mapping types had only a few extra plots to use in the accuracy assessment. The map was more accurate after including as much ground truth data as possible into a training set to use in the classification, so we decided better accuracy was a higher priority than having a quantitative accuracy assessment, especially since the number of plots was inadequate to evaluate accuracy for some mapping units. Accuracy assessment routines were run several times with plots that were not initially included in the training set. The plots that were incorrectly classified were often incorporated into the training set and the classification was run again, usually with better results as judged by ecologists familiar with the vegetation patterns of the front and by comparisons with aerial photography.

RESULTS AND DISCUSSION

Mapping Accuracy

A comprehensive accuracy assessment was not possible due to the limited availability of points with confirmed ground truth data. However, the accuracy assessment routines do give insight into the mapping classes that are likely to be confused. Grassland types are known to be difficult to

separate to species dominance groups; fescue types are probably relatively well classified but may be confused with the upland shrub type that also typically has a fescue component. Forested types separated fairly well, especially the conifer and limber pine types, although occasionally a sparse canopy of Douglas-fir was classified as a limber pine type. Aspen was more troublesome and was sometimes confused with both upland and wetland/riparian shrub types.

Mapping Type Descriptions

Forested - Aspen

This mapping type is comprised mostly of the Rocky Mountain Aspen Forest and Woodland Ecological System (CES306.813) and to a lesser degree the Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804) and possibly even Northwestern Great Plains Riparian (CES303.677). All ecological systems in Montana are currently under review; additionally the study area spans an ecological transition between montane and Great Plains environments. The two latter systems are cited because a limited set of the plant associations composed of trembling aspen and the associated black cottonwood (*P. balsamifera* ssp. *trichocarpa*) are present at the very westernmost margin of Great Plains topography and continue on to the foothill and lower mountain slopes. Aspen also occurs mixed with narrowleaf cottonwood (*P. angustifolia*) to a lesser extent.

Aspen occurs as small to large stands, usually associated with aeolian deposits generated during early Holocene time or landscape features related to subirrigation, such as riparian stringers or other sources of moisture augmentation like lee slopes receiving drifted snow and protection from desiccating winds. Canopy cover of the tree component is mostly greater than 75% and the height of the dominant trembling aspen seldom exceeds 55 ft. Associated canopy and subcanopy species include Douglas-fir, and Engelmann by white spruce (*Picea engelmannii* x *P. glauca*) hybrids with black poplar on the most mesic to hydric sites. The undergrowth consistently has at least 100% canopy cover. A sward of bluejoint

reedgrass (*Calamagrostis canadensis*) and less abundant sedges (*Carex* spp.) or foxtail grasses (*Alopecurus* spp.) dominates wetter sites, while drier sites have pine grass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*) and possibly a layer of common snowberry (*Symphoricarpos albus*). Mesic sites are species rich with a rather unique suite of forbs, some of which are important components of the grizzly bear spring diet, including cow parsnip (*Heracleum maximum*), western sweetroot (*Osmorhiza occidentalis*), angelica species (*Angelica* spp), tall groundwel (*Senecio hydrophiloides*), falsegold groundsel (*Packera pseud aurea* = *Senecio pseud aureus*), Richardson's geranium (*Geranium richardsonii*) and Sitka valerian (*Valeriana sitchensis*).

Detailed information on plant associations can be found at www.mtnhp.org or by contacting MTNHP ecologists.

Rocky Mountain Aspen Forest and Woodland Ecological System (CES306.813)

Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland Ecological System (CES306.804)

Plant Associations confirmed or hypothesized to occur in this mapping type include:

- *Populus balsamifera* ssp. *trichocarpa* / *Calamagrostis canadensis* Forest (See International Peace Parks Classification)
- *Populus balsamifera* ssp. *trichocarpa* / *Cornus sericea* Forest (CEGL000672)
- *Populus tremuloides* – *Populus balsamifera* ssp. *trichocarpa* / *Osmorhiza occidentalis* Forest (CEGL000542, G2Q)
- *Populus tremuloides* – *Populus balsamifera* ssp. *trichocarpa* / *Calamagrostis canadensis* Forest (CEGL002097)
- *Populus tremuloides* / *Amelanchier alnifolia* Forest (CEGL000564, G4)
- *Populus tremuloides* / *Calamagrostis canadensis* Forest (CEGL000547, G3)
- *Populus tremuloides* / *Calamagrostis rubescens* Forest (CEGL000575, G5?)
- *Populus tremuloides* / *Carex geyeri* Forest (CEGL000579, G4)
- *Populus tremuloides* / *Heracleum maximum* Forest (CEGL000595, G3)

- *Populus tremuloides* / *Juniperus communis* Forest (CEGL000587, G4)
- *Populus tremuloides* / *Poa pratensis* Forest (CEGL003148, GNR)
- *Populus tremuloides* / *Prunus virginiana* Forest (CEGL000596, G3G4)
- *Populus tremuloides* / *Symphoricarpos albus* Forest (CEGL000609, G3?)
- *Populus tremuloides* / *Urtica dioica* Forest [Provisional] (CEGL005849, G2G3)
- *Populus tremuloides* / *Spiraea betulifolia* Forest (CEGL000607, G4Q)

Forested - Conifer

Virtually all of this mapping type (Figure 3) is encompassed by the Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest Ecological System (CES306.805). There is an area near Rogers Pass that qualifies as Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland Ecological System (CES306.828) and in the same area at lowest elevations occurs fragments of the Northern Rocky Mountains Ponderosa Pine Woodland (CES306.030). At higher elevations, Rocky Mountain Lodgepole Pine Forest (CES303.820) generally occurs as a seral component. This type is on north- to east-facing slopes of ridge systems in the close proximity of the Front; within the mountains proper this type is found from the lowest elevations on all aspects upward to the subalpine zone (which occurs at much lower elevations on north aspects). The study area includes very little subalpine terrain. This mapping type is relatively simplistic along the Rocky Mountain Front where, due to the ubiquity of limestone substrates, stands are usually relatively open and dominated by Douglas-fir, both in seral and old-growth stands; northerly exposures favor significantly more closed stands. Limber pine is a common associate of Douglas-fir on these calcareous substrates and lodgepole pine (*Pinus contorta*) is a relatively short lived (110-150 years) seral dominant, tending to die-out within a narrow time window. There is very little lodgepole pine near the Rocky Mountain Front, perhaps because the calcareous substrates favor Douglas-fir. This type has also established, with at least 25% cover, on what once were unstable scree and talus slopes.



Figure 3. Forested-Conifer. Douglas-fir dominates the uplands along the Upper Dearborn River.

Most of this stabilized scree is dominated by Douglas-fir, limber pine (or mixes of the two) and lodgepole pine at higher elevations. Ponderosa pine (*Pinus ponderosa*) is a minor seral associate occurring only near Roger's Pass and somewhat to the north; its small range is attributable to limiting temperatures and the predominance of calcareous substrates to the north (competitively favoring Douglas-fir and limber pine). Engelmann spruce x white spruce hybrid swarms (closer to Engelmann spruce) occur near slope bottoms within the upper montane to subalpine zone and along riparian habitat immediately adjacent to and within the Front. There are extensive areas along the Front that have experienced catastrophic fire with very slow forest recovery, such as the Canyon Creek Fire of 1988, and are now vegetated with shrubs and grasslands (and mapped as such) (Figure 4). Where significant precipitation events followed



Figure 4. Grassland – Fescue and Shrubland – Upland. The east-facing slope beyond the grassland was burned in the Canyon Creek Fire of 1988 and has yet to reforest.

stand-replacing fire soil erosion was extensive and reforestation has not occurred in the intervening 50 years or more.

The undergrowth is relatively open and has limited species diversity. Where stands are especially open, as on rocky terrain or in early seral condition, bunchgrasses may exceed 20% cover and include rough fescue, bluebunch wheatgrass, Idaho fescue, timber oatgrass (*Danthonia intermedia*) and western needlegrass (*Achnatherum occidentale*). Pine grass is virtually ubiquitous in this type as both a seral and climax species (at least as expressed along the Front). Elk sedge is also present, but more in response to seral conditions. Shrubs with the highest constancy and coverage include common snowberry, white spiraea (*Spiraea betulifolia*), russet (or Canada) buffaloberry (*Shepherdia canadensis*), twinflower (*Linnaea borealis*), Oregon boxleaf (*Paxistima myrsinites*), Saskatoon serviceberry, Wood's rose (*Rosa woodsii*), common juniper (*Juniperus communis*), creeping juniper and kinnikinnick. The most common forbs are heartleaf arnica (*Arnica cordifolia*), eastern showy aster (*Eurybia conspicua* = *Aster conspicuous*), bluebell bellflower (*Campanula rotundifolia*), northern bedstraw (*Galium boreale*), timber milkvetch (*Astragalus miser*), sweetcicely (*Osmorhiza berteroi* formerly *O. chilensis*) and western meadowrue (*Thalictrum occidentale*).

Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest Ecological System (CES306.805)

Plant Associations confirmed or hypothesized to occur in this mapping type include:

- *Acer glabrum* Avalanche Chute Shrubland (CEGL000172)
- *Amelanchier alnifolia* / *Pseudoroegneria spicata* Shrubland (CEGL001065)
- *Pinus flexilis* Scree Woodland (CEGL000815, G3)
- *Pinus contorta* / *Arctostaphylos uva-ursi* Forest (CEGL000134)
- *Pinus contorta* / *Arnica cordifolia* Forest (CEGL000135)
- *Pinus contorta* / *Calamagrostis rubescens* Forest (CEGL000139)

- *Pinus contorta* / *Carex geyeri* Forest (CEGL000141)
- *Pinus contorta* / *Linnaea borealis* Forest (CEGL000153)
- *Pinus contorta* / *Shepherdia canadensis* Forest (CEGL000163)
- *Pinus contorta* / *Spiraea betulifolia* Forest (CEGL000164)
- *Pinus contorta* / *Vaccinium cespitosum* Forest (CEGL000168)
- *Pinus contorta* / *Vaccinium scoparium* Forest (CEGL000172)
- *Pseudotsuga menziesii* / *Arctostaphylos uva-ursi* Forest (CEGL000424, G4)
- *Pseudotsuga menziesii* / *Arnica cordifolia* Forest (CEGL000427, G4)
- *Pseudotsuga menziesii* / *Calamagrostis rubescens* Woodland (CEGL000429, G5)
- *Pseudotsuga menziesii* / *Carex geyeri* Forest (CEGL000430, G4?)
- *Pseudotsuga menziesii* / *Carex rossii* Forest (CEGL000431, G2?)
- *Pseudotsuga menziesii* / *Juniperus communis* Forest (CEGL000439, G4)
- *Pseudotsuga menziesii* / *Linnaea borealis* Forest (CEGL000441, G4)
- *Pseudotsuga menziesii* / *Mahonia repens* Forest (CEGL000442, G5)
- *Pseudotsuga menziesii* / *Osmorhiza berteroi* Forest (CEGL000445, G4G5)
- *Pseudotsuga menziesii* / *Spiraea betulifolia* Forest (CEGL000457, G5)
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest (CEGL000462, G5)
- *Pseudotsuga menziesii* / *Symphoricarpos albus* Forest (CEGL000459, G5)
- *Pseudotsuga menziesii* Scree Woodland (CEGL000911, G5)

Forested - Limber Pine

This mapping type (Figure 5) falls entirely within the Rocky Mountain Foothill Limber Pine – Juniper Woodland Ecological System (CES306.955). It occurs from the westernmost portion of the plains (where precipitation is slightly higher and soil is derived from highly calcareous glacial drift) to the foothill region to well within the reefs and escarpments of the Rocky Mountain Front. It typically occurs on thin soils, often with abundant

surface gravel and rock. When this type occurs within the main mountain mass it is confined to moderate to steep south-facing slopes and west-facing slopes (if the position is steep, has thin soils and receives the brunt of prevailing southwesterly winds). It does occur on a few ridges somewhat removed from the front and in these cases it is always associated with limestone outcrops.



Figure 5. Forested – Limber Pine. Undergrowth dominated by rough fescue and creeping juniper on a gentle south-facing slope with limestone-derived soils. Mortality of mature limber pines due to white pine blister rust is evident.

Limber pine dominates the canopy, which is primarily open but highly variable, having from 15 to 75% cover; mature canopy height ranges between 15 and 22 ft. Rocky mountain juniper (*Juniperus scopulorum*) and Douglas-fir have a minor presence with their combined cover seldom exceeding 10%. It appears that denser canopies have more Douglas-fir; these may be successional to a Douglas-fir vegetation type (limber pine not does not regenerate successfully under shaded understories). The undergrowth ranges from dominance by bunchgrasses, e.g. bluebunch wheatgrass on the most open, exposed south-facing slopes or, if conditions are moister, rough fescue (*Festuca campestris*) and Idaho fescue (*F. idahoensis*). There are some extensive flats and foothills along the Front where dwarf shrubs, primarily creeping juniper (*Juniperus horizontalis*) and kinnikinnick (or bearberry) comprise the dominant undergrowth; both species tend to form centripetally expanding patches with their combined

cover approaching 80% on a per plot basis. This condition of dwarf-shrub dominance has not been recognized by a unique syntaxonomic type, but probably should be. Stands with appreciable Canada buffaloberry (*Shepherdia canadensis*), common snowberry (*Symphoricarpos albus*), creeping mahonia (*Mahonia repens*), and pine grass (*Calamagrostis rubescens*) indicate a transition to more mesic conditions and probably eventual dominance by Douglas-fir.

We noted a massive die-off of limber pine. We believe most, if not all, mortality is due to white pine blister rust (*Cronartium ribicola*). Some have suggested that drought could be the cause of much of this mortality. Since the less drought tolerant Douglas-fir have not experienced this mortality; we believe that drought is only a contributing factor, perhaps hastening limber pine mortality after rust infection. In some relatively extensive areas, the mortality has been so pervasive that woodlands have become dwarf-shrublands dominated by bearberry, creeping juniper and bunchgrasses.

Rocky Mountain Foothill Limber Pine – Juniper Woodland Ecological System (CES306.955)

Plant Associations confirmed or hypothesized to occur in this mapping type include:

- *Pinus flexilis* / *Festuca campestris* Woodland (CEGL000806, G3)
- *Pinus flexilis* / *Festuca idahoensis* Woodland (CEGL000805, G5)
- *Pinus flexilis* / *Juniperus communis* Woodland (CEGL000807, G5)
- *Pinus flexilis* / *Pseudoroegneria spicata* Woodland (CEGL000813, G4?)
- *Pinus flexilis* / Scree Woodland (CEGL000815, G3Q)

Shrubland - Upland

This mapping type (Figure 6) is comprised mostly of the Northwestern Great Plains Shrubland Ecological System (CES303.662) and occurs primarily along stream and river terraces or mesic north-facing slopes. However, also present are very minor representatives of the Inter-Mountain Basins Greasewood Flat System (CES304.780).

The Shrubland system, dominated by shrubby cinquefoil (*Dasiphora floribunda* = *Potentilla fruticosa* or *Pentaphylloides floribunda*), is most extensive in the northwestern portion of the study area immediately east of the escarpment (an area with a relatively higher amount of precipitation). The cover of shrubby cinquefoil is highly variable and ranges from about 10% to 60%; the higher cover appears to be associated with greater amounts of grazing disturbance and higher amounts of soil moisture (as inferred by undergrowth composition). None of the stands examined had the composition and cover of bunchgrasses as described by Mueggler and Stewart (1980), who examined stands in “excellent to good condition”; grazing practices may have altered composition toward introduced pasture grasses, most particularly Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*) and smooth brome (*Bromus inermis*). The most mesic shrubby cinquefoil-dominated vegetation, which experiences saturated conditions early in the growing season and has fine-textured soils, should have tufted hairgrass (*Deschampsia caespitosa*) and western wheatgrass dominant, but has been largely grazing modified to Baltic rush (*Juncus balticus*) or smooth brome dominance.



Figure 6. Shrubland – Upland. Gently rolling terrain near the Front escarpment is dominated by the shrubby cinquefoil / rough fescue plant association. This variable density is typical of these stands with greater shrub cover on more mesic positions.

Associated with the extensive mostly flat areas of calcareous glacial drift along the escarpment from

just south of the Teton River northward is a unique vegetation type characterized by patches of creeping juniper. In some areas the patches have expanded sufficiently to coalesce and its canopy cover may be in excess of 70%. Another dwarf-shrub, kinnikinnick, can be a component of this vegetation type; there seems to be a gradient of kinnikinnick cover, increasing as one approaches the escarpment. The herbaceous component, in terms of species composition, is virtually the same as the rough fescue – Idaho fescue plant association, but the cover of the bunchgrass component is notably reduced, probably due to competition with the dwarf-shrubs. With intensive grazing the bunchgrass component, principally rough fescue, Idaho fescue, bluebunch wheatgrass, and the non-bunchgrass western wheatgrass can be nearly eliminated. Where this has occurred, and in conjunction with the desiccating winds along the Front, the result has been herb-dominated vegetation distinctly reminiscent of alpine fellfields. This creeping juniper dwarf-shrub vegetation is notable because: 1) it has not been previously described, 2) it bears a strong resemblance to kinnikinnick / rough fescue and kinnikinnick / Idaho fescue associations described from Glacier and Waterton International Parks (and nowhere else), 3) it is increasing in extent (due to the white pine blister rust-induced mortality of limber pine and the fact that the undergrowth of much of the limber pine-dominated stands has a similar vegetation composition).

Western snowberry (*Symphoricarpos occidentalis*) forms small patch communities in places with additional soil moisture like swales, steep lee slope positions, riparian zones and old alluvial terraces of narrower floodplains. These areas attract cattle, and vegetation is usually altered toward exotic pasture grass (and Baltic rush) dominance in the herbaceous layer; very little, if any, remain of what were probably the dominant graminoids: western wheatgrass, slender wheatgrass (*Elymus trachycaulus*) and tufted hairgrass.

Although sagebrush communities, mostly Wyoming big sagebrush (*A. tridentata* ssp. *wyomingensis*), occur extensively both east and south of the study

area, the only sagebrush communities along the front are several areas of mountain big sage (*A. tridentata* ssp. *vaseyana*) types at higher locations at several places along the Front. Immediately south of the mapping area Wyoming big sagebrush is a community dominant at lower elevations overlapping those found in the study area. We are aware of no plausible explanation for this pattern.

Northwestern Great Plains Shrubland

Ecological System (CES303.662)

Inter-Mountain Basins Greasewood Flat

Ecological System (CES304.780)

Plant Associations confirmed or hypothesized to occur in this mapping type include:

- *Dasiphora fruticosa* ssp. *floribunda* / *Dechampsia caespitosa* Shrubland (CEGL001107, G4)
- *Dasiphora fruticosa* ssp. *floribunda* / *Festuca campestris* Shrub Herbaceous Vegetation (CEGL001503, G4)
- *Dasiphora fruticosa* ssp. *floribunda* / *Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001502, G4)
- *Juniperus horizontalis* / *Festuca campestris* Shrub Herbaceous Vegetation (No formal designation)
- *Juniperus horizontalis* / *Festuca idahoensis* Shrub Herbaceous Vegetation (No formal designation)
- *Sarcobatus vermiculatus* / *Pascopyrum smithii* Shrub Herbaceous Vegetation (CEGL001508, G4)
- *Symphoricarpos occidentalis* Shrubland (CEGL001131, G4G5)
- *Atriplex gardneri* Dwarf Shrubland (CEGL001438, G3G5)
- *Atriplex gardneri* / *Pascopyrum smithii* Dwarf-shrubland (CEGL1445, G3)
- *Sarcobatus vermiculatus* / *Atriplex gardneri* Shrubland (CEGL001360, G4?)
- *Sarcobatus vermiculatus* / *Distichlis spicata* Shrubland (CEGL001363, G4)
- *Sarcobatus vermiculatus* / *Pascopyrum smithii* - (*Elymus lanceolatus*) Shrub Herbaceous Vegetation (CEGL001508, G4)

Shrubland - Riparian

Although this is a relatively common mapping type and one that traverses the whole of the study area, little is accessible on public lands (generally only where north-south trending roads intersect drainages and floodplains). The following ecological systems appear to occur within the mapping area: Northwestern Great Plains Floodplain (CES303.676), Northwestern Great Plains Riparian (CES303.677), and Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804). As currently defined/described these Ecological Systems appear to be inadequately delineated, they overlap considerably on the landscape and are strongly coincident in the characteristic plant associations cited for each. As mentioned earlier, these ecological systems are still being refined for Montana. The list below of plant associations is an attempt to be inclusive. Some of the cited types are not in the NVCS but are well documented as a result of the work of Hansen et al. (1995); they treat presumed seral vegetation as community types and speculate as to what habitat type (climax plant association) a given type might succeed to given enough time and lack of disturbance. From the surveys of Hansen et al. (1995) and our own limited field reconnaissance in the study area, it is obvious that the native vegetation of these systems is under threat from agriculture, such as intensive grazing utilization converting the undergrowth to pasture grasses, and the influx of noxious weeds.

Northwestern Great Plains Floodplain Ecological System (CES303.676) and Northwestern Great Plains Riparian Ecological System (CES303.677)

Plant Associations confirmed or hypothesized to occur in this mapping type include:

- *Alnus incana* / Mesic Forbs Shrubland (CEGL001147, G3G4Q)
- *Alnus incana* / Mesic Graminoids Shrubland (CEGL001148, G2G3?)
- *Calamagrostis canadensis* Western Herbaceous Vegetation (CEGL001559, G4Q)
- *Carex nebrascensis* Herbaceous Vegetation (CEGL001813, G4)
- *Carex praegracilis* – *Carex aquatilis* Herbaceous Vegetation (CEGL001821, G2G3Q)
- *Carex utriculata* Herbaceous Vegetation (CEGL001562, G5)
- *Cornus sericea* / *Heracleum maximum* Shrubland (CEGL1167, G3)
- *Cornus sericea* Shrubland (CEGL001165, G4Q)
- *Elaeagnus commutata* Shrubland (CEGL001098, G2Q)
- *Juncus balticus* Herbaceous Vegetation (CEGL001838, G5)
- *Populus angustifolia* / *Cornus sericea* Forest (CEGL00649, G4)
- *Populus angustifolia* / Herbaceous Vegetation (Hansen et al. 1995)
- *Populus angustifolia* / Recent Alluvial Bar Vegetation (Hansen et al. 1995)
- *Populus deltoides* / *Cornus sericea* Forest (CEGL000657, G3)
- *Populus deltoides* / Herbaceous Vegetation (Hansen et al. 1995)
- *Populus deltoides* / Recent Alluvial Bar Vegetation (Hansen et al. 1995)
- *Populus deltoides* / *Symphoricarpos occidentalis* Woodland (CEGL000660, G2G3)
- *Populus tremuloides* / *Cornus sericea* Forest (CEGL000582, G4)
- *Populus tremuloides* / *Calamagrostis canadensis* Forest (CEGL000574, G3)
- *Populus tremuloides* / *Poa pratensis* Forest (Hansen et al. 1995)
- *Populus balsamifera* ssp. *trichocarpa* / *Cornus sericea* Forest (CEGL0000672, G3?)
- *Populus balsamifera* ssp. *trichocarpa* / Herbaceous Vegetation (Hansen et al. 1995)
- *Populus balsamifera* ssp. *trichocarpa* / Recent Alluvial Bar Vegetation (Hansen et al. 1995)
- *Rosa woodsii* Shrubland (CEGL1126, G5)
- *Salix bebbiana* / Mesic Graminoids Shrubland (CEGL001174, G3?)
- *Salix bebbiana* Shrubland (CEGL001173, G3?)
- *Salix boothii* / Mesic Graminoids Shrubland (CEGL001181, G3?)
- *Salix drummondiana* / *Carex utriculata* Shrubland (CEGL002631, G3)
- *Salix drummondiana* / *Calamagrostis canadensis* Shrubland (CEGL001191, G2)

- *Salix drummondiana* Shrubland (CEGL001190, G3Q)
- *Salix exigua* Temporarily Flooded Shrubland (CEGL001197, G5)
- *Salix interior* Temporarily Flooded Shrubland (CEGL008562, G4G5)
- *Salix planifolia* Shrubland (CEGL001224, G4)
- *Symphoricarpos occidentalis* Shrubland (CEGL001131, G4G5)
- *Typha latifolia* Western Herbaceous Vegetation (CEGL002010, G5)

Wetland - Herbaceous

Occurrences of this type are predominantly small patches and mapped separately as the NWI type Palustrine Emergent or Lacustrine. These include the following ecological systems: North American Arid West Emergent Marsh (CES300.729), Rocky Mountain Subalpine-Montane Fen (CES306.831), Great Plains Prairie Pothole (CES303.661), Western Great Plains Closed Depression Wetland (CES303.666) and Western Great Plains Open Freshwater Depression Wetland (CES303.675). Extensive areas of this mapping type probably existed prior to settlement, such as in the Flat Creek vicinity; with settlement native wetlands were converted to hay meadows and mostly planted to exotic pasture grasses.

Rocky Mountain Subalpine-Montane Fen Ecological System (CES306.831): (all component communities described by Hansen et al. 1995)

North American Arid West Emergent Marsh Ecological System (CES300.729): (all component communities described by Hansen et al. 1995 or NVCS)

Western Great Plains Closed Depression Wetland Ecological System (CES303.666)

Great Plains Prairie Pothole Ecological System (CES303.661)

Western Great Plains Open Freshwater Depression Wetland Ecological System (CES303.675) (The vegetation types comprising this system are found in the systems listed above).

Plant associations that were encountered or known to occur in Herbaceous Wetlands along the Front are listed below.

- *Betula nana* / *Carex* spp. Shrubland (CEGL005887, GNR)
- *Carex buxbaumii* Herbaceous Vegetation (CEGL001806, G3)
- *Carex lasiocarpa* Herbaceous Vegetation (CEGL001810, G4?)
- *Carex limosa* Herbaceous Vegetation (CEGL001811, G2)
- *Carex simulata* Herbaceous Vegetation (CEGL001825, G4)
- *Carex utriculata* Herbaceous Vegetation (CEGL001562, G5)
- *Calamagrostis canadensis* Western Herbaceous Vegetation (CEGL001559, G4)
- *Carex nebrascensis* Herbaceous Vegetation (CEGL001813, G4)
- *Carex utriculata* Herbaceous Vegetation (CEGL001562, G5)
- *Eleocharis (montevidensis, palustris, quinqueflora)* Seasonally Flooded Herbaceous Vegetation (CEGL003050, G5)
- *Juncus balticus* Herbaceous Vegetation (CEGL001838, G5)
- *Myriophyllum sibiricum* Herbaceous Vegetation (CEGL002000, GUQ)
- *Schoenoplectus acutus* Herbaceous Vegetation (CEGL001840, G5)
- *Schoenoplectus americanus* Western Herbaceous Vegetation (CEGL001841, G3Q)
- *Schoenoplectus maritimus* Herbaceous Vegetation (CEGL001843, G4)
- *Typha (latifolia, angustifolia)* Western Herbaceous Vegetation (CEGL002010, G5)
- *Eleocharis palustris* Herbaceous Vegetation (CEGL001833, G5)
- *Hordeum jubatum* Herbaceous Vegetation (CEGL001798, G4)
- *Pascopyrum smithii* - *Distichlis spicata* Herbaceous Vegetation (CEGL001580, G4)
- *Pascopyrum smithii* - *Eleocharis* spp. Herbaceous Vegetation (CEGL001581, G1)
- *Pascopyrum smithii* - *Hordeum jubatum* Herbaceous Vegetation (CEGL001582, G4)
- *Sarcobatus vermiculatus* / *Leymus cinereus* Shrubland (CEGL001366, G3)

- *Schoenoplectus maritimus* - *Schoenoplectus acutus* - (*Triglochin maritima*) Herbaceous Vegetation (CEGL002227)
- *Schoenoplectus maritimus* Herbaceous Vegetation (CEGL001843)

Wetland - Other NWI types

Six NWI System or Class types were aggregated and retained in the map. Since these are very diverse and not the primary focus we only detailed vegetation for the two most common types, Palustrine Emergent and Lacustrine (see above as the Herbaceous Wetland Mapping Unit). Also mapped as separate types are Riverine, Palustrine Forested, Palustrine Scrub-shrub, and Palustrine Unconsolidated Shore or Aquatic Bed (combined). The Palustrine Forested type (Figure 7) will include some of the vegetation associations detailed in the Aspen mapping type.



Figure 7. Wetlands – Palustrine Forested and Scrub-Shrub. A leaf-off stand of black cottonwood along Upper Smith Creek; the undergrowth is dominated by beaked sedge and bluejoint reedgrass. Drummond's willow is the scattered red-orange shrub.

Grasslands - Fescue

This mapping unit (Figure 8) includes two Ecological Systems, Northern Rocky Mountain Montane and Foothill Grassland (CES306.040) and Northwestern Great Plains Mixedgrass Prairie (CES303.674). As noted above the study area encompasses the transition from a Great Plains environment to a foothills/montane zone and an ecotone in grassland types also occurs.

Approaching the mountain front from the plains, Idaho fescue is typically the first fescue encountered; it is more adapted to droughty conditions than rough fescue (*F. campestris*). These Idaho fescue communities are usually confined to north- or east-facing, moderate to steep slopes, with greater effective moisture. Exceptions to this pattern occur, we encountered areas where rough fescue was the first-encountered fescue when moving from east to west. If the soils have somewhat finer texture (e.g. silt and clay loams), then western wheatgrass is potentially an important component (Idaho fescue / western wheatgrass plant association). Associated with coarser soil textures and higher insolation is bluebunch wheatgrass, which is seldom dominant. On areas with less relief or having south- to west-facing slopes and loamy soils, bluebunch and western wheatgrass occur mixed with Idaho fescue. This community type has historically been subjected to domestic stock grazing and the less grazing-resistant Idaho fescue has been highly reduced or even locally extirpated (these areas now typically map to the Fine- to Medium-Textured Soils Mapping Type). Even more grazing-susceptible is rough fescue (probably due to a higher growing point) and one can easily overlook its presence or even mistake it for western wheatgrass when tussocks are reduced to a few culms and none of them are flowering.



Figure 8. Grassland – Fescue. Rough fescue and Idaho fescue dominated grassland.

As one approaches the Front the proportion of the landscape with rough fescue as a community component and dominant increases and this species moves onto flatter terrain as well. These locations may receive greater amounts of precipitation despite the marginal gain in elevation; this is due to a “blowover” effect where orographically stimulated precipitation is blown far to the lee of where it was initiated. Where increases in precipitation occur due to the convergence of local airstreams (well-documented in other geographic regions), rough fescue could extend eastward further into the plains environment. The most common rough fescue association is rough fescue – Idaho fescue, in which the nominal species are dominant and prairie junegrass (*Koeleria macrantha*) and timber oatgrass are the only other grasses of consequence (high constancy but low cover). Common forbs include western stoneseed (*Lithospermum ruderale*), old man’s whiskers (*Geum triflorum*), rosy pussytoes (*Antennaria rosea*), silky lupine (*Lupinus sericeus*) and common yarrow (*Achillea millefolium*). In analogy with the Idaho fescue – bluebunch wheatgrass association the rough fescue – bluebunch wheatgrass association occurs on warmer, drier exposures, but generally closer to the Front where precipitation is greater. Forb composition is reduced in number and cover relative to other rough fescue types and is closer to that of the plains with a lack of species with more mesic affinities. Common species include dotted blazing star (*Liatris punctata*), nodding onion (*Allium cernuum*), violet prairie clover (*Dalea purpurea*), spiny phlox (*Phlox hoodii*) and scarlet beeblossom (*Gaura coccinea*).

The most mesic rough fescue-dominated communities are small patches characterized by the rough fescue / sticky geranium (*Geranium viscosissimum*) plant association in which mesic forbs are prominent, including, among others, sticky geranium, aspen fleabane (*Erigeron speciosus*), slender cinquefoil (*Potentilla gracilis*), tall cinquefoil (*P. arguta*), lambstongue ragwort (*Senecio integerrimus*), sulphur-flower buckwheat (*Eriogonum umbellatum*) and bluebell bellflower (*Campanula rotundifolia*). This community is more associated with montane environments and is

restricted in the plains and foothill landscapes to toeslopes, swales, and lee slopes that receive heavy snow accumulations. Even more restricted to mesic, montane environments and rare within the mapping area is the rough fescue – Richardson’s needlegrass (*F. campestris* – *Achnatherum richardsonii*) plant association. It is also forb-rich, verging on a meadow condition, but graminoids, including the nominal species and timber oatgrass, are definitely dominant, often having in excess of 80% combined canopy cover.

Northern Rocky Mountain Montane and Foothill Grassland Ecological System (CES306.040)

Northwestern Great Plains Mixedgrass Prairie Ecological System (CES303.674)

Plant Associations confirmed or hypothesized to occur in this mapping type include:

- *Calamagrostis rubescens* Herbaceous Vegetation (CEGL005862, G3G4?)
- *Elymus repens* Semi-natural Herbaceous Vegetation (CEGL005868, GNA)
- *Festuca campestris* - (*Festuca idahoensis*) - *Achnatherum richardsonii* Herbaceous Vegetation (CEGL005869, G2G3?)
- *Festuca campestris* - *Festuca idahoensis* - *Geranium viscosissimum* Herbaceous Vegetation (CEGL005870, G3?)
- *Festuca campestris* - *Festuca idahoensis* Herbaceous Vegetation (CEGL005875, G3)
- *Festuca campestris* - *Pseudoroegneria spicata* Herbaceous Vegetation (CEGL001629, G4)
- *Festuca idahoensis* - *Koeleria macrantha* Herbaceous Vegetation (CEGL001620, G3Q)
- *Festuca idahoensis* - *Leucopoa kingii* Herbaceous Vegetation (CEGL001901, G2?)
- *Festuca idahoensis* - *Pascopyrum smithii* Herbaceous Vegetation (CEGL001621, G4)
- *Festuca idahoensis* - *Pseudoroegneria spicata* Herbaceous Vegetation (CEGL001624, G4)

Grasslands - Coarse-textured Soils

The Western Great Plains Sand Prairie (CES303.670) is the Ecological System most likely to eventually contain this subset mapping type (Figure 9), but as currently conceived, this

Ecological System does not extend to the Northwestern Great Plains (which includes our study area). As currently described, and by virtue of a couple of attributed plant associations, the Northwestern Great Plains Mixedgrass Prairie (CES303.674) would contain this mapping type. However, with proposed amendments to this Ecological System all coarse textured components will probably be incorporated in the Western Great Plains Sand Prairie.



Figure 9. Grassland – Coarse-Textured Soils. Needle-and-thread / Blue grama plant association forms the dominant vegetation (grazed this year, photo from late in season after grasses have cured).

The most common plant community found within this mapping type is needle-and-thread – blue grama herbaceous vegetation. It is present as both a potential vegetation type, representative of the driest grassland habitat type in western Montana, and as a grazing disclimax probably derived from communities once dominated by bluebunch wheatgrass, western wheatgrass or even fescue species. This conclusion is somewhat speculative since there are no exclosures in the vicinity of the RMF that have been established for a sufficiently long period that could be used to test hypotheses regarding grazing alteration of community composition. Certainly, the above-cited plant association does occur on loamy textured soils as well as the expected sandy loams, loamy sands, and sands. Needle-and-thread grass is a good indicator of coarse-textured soils whereas blue grama is more broadly distributed with regard to

soil texture. However, due to the low stature of blue grama it can increase markedly on heavily grazed ranges. On some intensively grazed terraces with loamy to even finer textured soils, areas that would potentially be dominated by western wheatgrass and the western wheatgrass – blue grama plant association, the wheatgrass has been virtually extirpated, the needle-and-thread reduced to less than 5% cover and blue grama is dominant with more than 40% canopy cover. Needleleaf sedge (*Carex duriuscula*, formerly *C. stenophylla* or *C. eleocharis*) and prairie junegrass have a high constancy with cover seldom exceeding 5% in this association, however, under some circumstances, most likely related to grazing regime, either or both species may increase markedly. Forb cover, seldom exceeding 10% and averaging around 3%, is much less than the more mesic fescue grasslands (cover to 70% and averaging 24%). The amount of bare soil in the needle-and-thread-dominated communities is 5 to 6 times that of the fescue-dominated communities and ground litter cover is approximately a third to a half of the fescue communities.

Other plant associations noted within this mapping type include bluebunch wheatgrass – blue grama, which is more associated with rocky substrates and occurs as small patches on moderate to steep, south to west-facing slopes. Two closely related associations, prairie sandreed (*Calamovilfa longifolia*) – bluebunch wheatgrass and prairie sandreed – needle-and-thread are rare within the mapping area and occur only on loamy sands and sands. The second named community is possibly the result of intensive grazing of the prairie sandreed – bluebunch wheatgrass community (bluebunch wheatgrass being much more palatable to ungulates, especially early in the season). According to the ecosite composition summaries of the Natural Resource Conservation Service, the bluebunch wheatgrass – needle-and-thread type should be a major component of this mapping type but it was encountered only once in a lightly grazed pasture and is thought to be mostly grazing-converted to needle-and-thread with other increaser grasses, typically blue grama, gaining dominance.

Western Great Plains Sand Prairie Ecological System (CES303.670)

Plant associations confirmed or hypothesized to occur in this mapping type include:

- *Bouteloua gracilis* Herbaceous Vegetation (CEGL001760, G4Q)
- *Calamovilfa longifolia* - *Hesperostipa comata* Herbaceous Vegetation (CEGL001473, G3)
- *Calamovilfa longifolia* – *Pseudoroegneria spicata* Herbaceous Vegetation (undescribed)
- *Hesperostipa comata* – *Bouteloua gracilis* Herbaceous Vegetation (CEGL001699, G5)
- *Hesperostipa comata* – *Bouteloua gracilis* – *Carex filifolia* Herbaceous Vegetation (CEGL002037, G3/G4)
- *Pseudoroegneria spicata* – *Bouteloua gracilis* Herbaceous Vegetation (CEGL001664, G4)
- *Pseudoroegneria spicata* – *Hesperostipa comata* Herbaceous Vegetation (CEGL001679, G4)
- *Pseudoroegneria spicata* – *Poa secunda* Herbaceous Vegetation (CEGL001677, G4?)
- *Rhus trilobata* / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001120, G4)

Grasslands - Fine-Textured Soils

This type (Figure 10) is largely contained within the Northwestern Great Plains Mixedgrass Prairie Ecological System (CES303.674). It includes those plant communities that are not dominated or indicated by the presence of either rough fescue or Idaho fescue, species more associated with mountain and foothill environments than with the prairie conditions that typify most of this mapping type and its signature species, western wheatgrass. This mapping type exists in a complex mosaic with the Western Great Plains Sand Prairie Ecological System, the respective systems determined primarily by contrasting soil textures, with this mapping type confined to fine- to medium-textured soils. What should be the most abundant grass in this system, western wheatgrass, has a broad amplitude with respect to soil texture, but is strongly associated with a moist soil regime, thus it can occur on relatively coarse substrates if moisture content is high (conditions not typical in this landscape). Western wheatgrass is extremely

palatable to all ungulates and, despite being highly adapted to grazing; its cover may have been highly grazing-reduced in this landscape. A common observation is that needle-and-thread and blue grama are community dominants on some sites, based on landscape position and soils, that would be expected to have western wheatgrass dominant.



Figure 10. Grassland – Fine-Textured Soil. Western wheatgrass is strongly dominant with lesser amounts of needle-and-thread and minor amounts of blue grama.

Bluebunch wheatgrass is much less abundant in this landscape than would be expected and may have been significantly reduced through grazing pressure, driving the bluebunch wheatgrass – western wheatgrass association to needle-and-thread dominance (much the same way the bluebunch – needle-and-thread association has been driven to needle-and-thread – blue grama on coarse-textured soils).

Many of these sites have been converted to hay production with the replacement of native species with introduced pasture grasses; some have flood irrigation, while the most productive upland silt loams are under dryland grain production. Remaining western wheatgrass-characterized communities in this landscape are usually large patches associated with fine-textured (“heavy”) soils often occurring on collecting or runoff positions such as basins, lower slopes (toe and footslope), and stream or river terraces. The most common plant association in this landscape, western wheatgrass – needle and thread, is similar

to the needle and thread – blue grama – western wheatgrass habitat type from western Montana (Mueggler and Stewart 1980), especially in regard to the relatively low cover of western wheatgrass (mostly < 10% cover). This observation contrasts with the relatively high western wheatgrass cover (>30%) described from stands of the same type in eastern Montana (DeVelice et al. 1995, eastern representatives have higher overall cover of graminoids as well). Silver sagebrush (*Artemisia cana* ssp. *cana*), broom snakeweed (*Gutierrezia sarothrae*) and hairy false goldenaster (*Heterotheca villosa*) are the most common shrubs/sub-shrubs, seldom exceeding 5% combined cover, but where grazing has been heavier silver sagebrush cover can approach 20% and hairy golden aster also increases. In addition to the nominal graminoids, prairie junegrass and needleleaf sedge have high constancy with cover generally less than 10%. The forb component generally does not exceed 10% cover, averaging about 4%; those with highest constancy include spiny phlox, dotted blazing star, scarlet beeblossom, scarlet globemallow (*Sphaeralcea coccinea*) and violet prairie clover. Associated with the most productive sites is the western wheatgrass – green needlegrass (*Nassella viridula*) association, but these sites have been utilized to the point that the highly palatable and grazing sensitive green needlegrass is seldom present in more than trace amounts (and this type probably underwent the most site conversion to agriculture due to its inherent productivity). These versions of Great Plains types differ in a few respects such as a) the comparative unimportance of several weedy species such as Japanese brome (*Bromus japonicus*), cheatgrass (*Bromus tectorum*) and rough false pennyroyal (*Hedeoma hispida*), b) threadleaf sedge is comparatively unimportant, c) the overall graminoid cover is less along the Front, principally due to lower western wheatgrass cover, and d) bluebunch wheatgrass is more common here than in eastern Montana but due to heavy ungulate utilization its cover is less.

Northwestern Great Plains Mixedgrass

Prairie Ecological System (CES303.674)

Plant Associations confirmed or hypothesized to occur in this mapping type include:

- *Pascopyrum smithii* - *Bouteloua gracilis* - *Carex filifolia* Herbaceous Vegetation (CEGL001579, G4)
- *Pascopyrum smithii* - *Nassella viridula* Herbaceous Vegetation (CEGL001583, G3G4)
- *Pascopyrum smithii* Herbaceous Vegetation (CEGL001577, G3G5Q)
- *Poa pratensis* - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation (CEGL005265, GNA)
- *Pseudoroegneria spicata* - *Pascopyrum smithii* Herbaceous Vegetation (CEGL001675, G4)

Agriculture

Four NLCD agricultural types were retained in the map including pasture/hay, row crops, small grains, and fallow.

Sparsely Vegetated – Low Elevation

This mapping unit was documented mostly via remote sensing, i.e. interpreting aerial photography or observing with binoculars. There are many and varied sources of barren substrates so several Ecological Systems are involved and usually they are distinguished on the basis of their geological origins or bedrock composition (Figure 11). The following systems have in common their inability to support more than 10% vascular plant cover (cover



Figure 11. Sparse Vegetation – Low Elevation. A massive outcrop of extrusive volcanic rock sparsely vegetated, predominantly in the fissures, with forbs such as spearleaf stonecrop (*Sedum lanceolatum*), alumroot (*Heuchera* spp.) and buckwheat (*Eriogonum* spp.).

averaged over the whole of the formation or type); some of these systems, usually badlands, may have clumps of vegetation with greater cover than 10%, but the intervening spaces are comparatively unoccupied. There are some areas near reservoirs that have been worked by earth-moving equipment leaving a sparsely vegetated surface on subsoil. In some cases only a rocky flat remains with minimal tussock grasses.

Inter-Mountain Basins Volcanic Rock and Cinder Land Ecological System (CES304.791)

This system was observed in several locations within the southeastern portion of the study area and appeared to consist of dikes, sills and mini-cones of the dark volcanic rock, shonkinite. Exposures of this 50 million year old formation are poorly vegetated, in some locations supporting dispersed tussocks of bluebunch wheatgrass in cracks and crevices; lack of access precluded more in depth vegetation descriptions.

Rocky Mountain Cliff, Canyon and Massive Bedrock Ecological System (CES306.815)

This ecological system of barren and sparsely vegetated landscapes is found from foothill to subalpine terrain on steep cliff faces, narrow canyons, and smaller rock outcrops of various bedrock types. In the study area the primary rock type is sedimentary, almost all is Madison limestone. The thrust faults that have occurred in the Sawtooth Range have left massive exposed cliff faces, sheer-sided “buttes” and rounded mountain summits (this last feature occurs at the very western periphery of the mapping area). As this ecological system is described at the national level it includes unstable scree and talus slopes (that typically occur below cliff faces); we have treated scree, talus, and allied conditions as a separate mapping type (High Altitude Sparsely Vegetated Mapping Type).

Western Great Plains Badlands and Shale Barrens Ecological System (CES303.663)

In north and west central Montana, badlands often are a mosaic of bare substrate with small patches of graminoids and /or shrubs that may considerably

exceed 10%, but overall the landscape exhibits less than 10% cover. This system is differentiated from those above due to its plains environment and an erosive substrate, often shales or mudstones, not slow to weather volcanic rock. In vegetated areas, species can include scattered individuals of many dry land shrubs and sub-shrubs, including broom snakeweed (*Gutierrezia sarothrae*, especially with overuse), black greasewood (*Sarcobatus vermiculatus*), Gardner’s saltbush (*Atriplex gardneri*), longleaf wormwood (*Artemisia longifolia*), prairie sagewort (*A. frigida*), creeping juniper, and buckwheat (*Eriogonum* spp.). In most of Montana, patches of big sagebrush (mostly *Artemisia tridentata* ssp. *wyomingensis*) can also occur, but this taxon is missing (or extremely rare) in the mapping area. This system can occur where the land lies well above or below its local base level and is created by several factors including elevation, rainfall, carving action of streams, and erosive parent material. Erosive shales are present on the plains immediately east of the Front and small badlands patches are present and especially numerous around Bynum Reservoir and immediately to the west.

Plant Associations confirmed or hypothesized to occur in this mapping type include:

- *Artemisia longifolia* Sparse Vegetation (CEGL001540, G3)
- *Atriplex gardnerii* Dwarf-shrubland (CEGL001438, G3G5)
- *Juniperus horizontalis* Dwarf-shrubland
- *Sarcobatus vermiculatus* / *Atriplex gardneri* Shrubland (CEGL001360, G4?)

Western Great Plains Cliff and Outcrop Ecological System (CES303.665)

This system includes cliffs and outcrops throughout the Western Great Plains Division. Substrates are highly variable including the granitics, sandstone and limestone found on the Front; often these barrens occur as banded features. Vegetation is restricted to shelves, cracks and crevices in the rock; within the plains of the mapping area limestone outcrops comprise almost all of this system. This system differs from Western Great Plains Badlands and Shale Barrens (CES303.663) in that often the soil is slightly developed and less

subject to erosion. Some grass and shrub species can occur at greater than 10% cover. Common species in this system include short shrubs such as skunkbush sumac (*Rhus trilobata*), kinnikinnick and longleaf wormwood, mixedgrass species such as blue grama, bluebunch wheatgrass, Ross' sedge (*Carex rossii*), prairie sandreed and a diversity of forbs including musk phlox (*Phlox hoodii* ssp. *muscoides*), Howard's alpine forget-me-not (*Eritrichium howardii*), springparsley species (*Cymopterus* spp.) and stemless mock goldenweed (*Stenotus acaulis* formerly *Haplopappus*). Drought and wind erosion are the most common natural dynamics affecting this system. No plant associations have yet been identified for this ecological system in Montana.

Sparsely Vegetated – High Elevation

This type contains scree (coarse debris mantling a mountain or foothill slope), talus (accumulation of coarse debris at the base of a cliff or escarpment) and other high altitude exposed rock or thin soil sparsely vegetated types. The inherently limiting nature of these environments allows for only sparse vegetation. Vegetation patches with canopy cover in excess of 10% do occur but the predominant cover is much sparser. There is a continuum between the virtually non-vegetated condition (found with coarse scree) and some tree canopy cover of 25% or less (usually Douglas-fir, limber pine and/or Rocky Mountain juniper) not confined to patches. These lightly forested areas occur because of the accumulation of fines below the rocky surface and a moisture supply from water percolated over and through the underlying massive bedrock. If the tree canopy cover is 25% or greater, even if the substrate is scree or talus, then these woodlands would be categorized as belonging to the coniferous mapping type (described by Pfister et al. [1977] as "forested scree").

This sparsely vegetated type on very rocky or thin-soil substrates is, in a number of cases examined, the result of slopes having burned very intensively (removing the protective vegetative cover) and then experiencing a significant precipitation event, which has eroded some portion of the soil mantle and drastically changed the potential of these sites. Primary succession must occur before sites are in

equilibrium with the environment. The condition most commonly observed is highly dispersed trees (including those listed above and lodgepole pine, cover mostly <10%, not exceeding 25%). Scattered clumps of short to tall shrubs provide most of the cover, typically russet buffaloberry, shrubby cinquefoil, chokecherry, Saskatoon serviceberry, common snowberry, creeping barberry, kinnikinnick, thimbleberry and common juniper. The herbaceous component is very poorly developed but consistently present are elk sedge, Ross' sedge (*C. rossii*), pine grass, sweetvetch (*Hedysarum* spp.), lousewort species (*Pedicularis* spp.), raceme pussytoes (*Antennaria racemosa*), and timber milkvetch. No formally described plant associations exist for these types because the expression is an early seral one (and seral communities have only recently been described for Montana).

Water

This type includes lentic water bodies of all sizes, from ponds with surface areas of a few acres to large bodies such as the numerous reservoirs and natural lakes, some of which have been enlarged by regulating outflow. Open water types with a depth <2 m are actually NWI Lacustrine wetlands and have been mapped with that designation.

Notable Landscapes

Three areas were sampled with high quality and/or unique ecological characteristics. The information below is also in the MTNHP database along with any plot data gathered at these sites.

Nilan Reservoir South Uplands

Location: This site (Figure 12) is located 5.5 air miles directly west of Augusta, MT at the northern extremity of Lewis and Clark County. At the intersection of State Rt. 287 and the county road bearing to the southwest take the county road which shortly will turn west at the western outskirts of Augusta. Follow to the eastern margin of Nilan Reservoir and go 0.1 mi. beyond marked picnic area and boat launching facility (about midpoint along southern shore of reservoir). Site is across fence and extends several tenths of a mile south and a few tenths of a mile both east and west.



Figure 12. Nilan Reservoir South Uplands.

General Description: This site is located in a transitional zone between the Great Plains environment with rhizomatous graminoids on fine-textured soils and xeric-adapted graminoids of sandy sites to a Rocky Mountain foothills area where dominance has shifted to the tussock grasses, rough fescue and Idaho fescue. Western wheatgrass is still present on finer soils here. Less than 250 ft vertical relief (4,455 to 4,666 ft) occurs in the gently undulating topography, though the faces of north-facing slopes may be rather steep. Surfaces are mantled with Pleistocene glacial drift derived mostly from Madison limestone. This drift has weathered to a silt loam texture. Soil rock content is highly variable with upper surfaces and southerly exposures having 20-50% rock content in the rooting portion compared to less than 10% rock in the upper soil of toeslopes and north-facing slopes.

Because vertical relief is relatively minor, the driving force producing a number of different plant communities is the interaction of slope, aspect and soil properties that affect moisture storage and supply. The most mesic community noted was small patches of rough fescue / sticky geranium on the steepest of north- and northeast-facing exposures (possibly sites of longer-persisting snow patches). In addition to the sticky geranium, these sites support both slender and tall cinquefoil. The next most mesic community, rough fescue – western wheatgrass, is also found on cooler exposures - moisture - collecting toeslope locations or low to steep gradient, north and northeast-facing

slopes that receive snow blowover. The flats and gentle southerly slopes support the rough fescue – Idaho fescue plant association. As slopes of southerly exposure become steeper the cover of bluebunch wheatgrass increases and the content and stature of rough fescue decreases. Bluebunch wheatgrass- dominated communities with ground-hugging forbs (bluebunch wheatgrass / cushion plant association) or other xeric graminoids associations (like bluebunch – needle-and-thread) occur on the steepest southerly or western exposures and ridge shoulders or crests (with shallow soils).

Detailed data and photos of vegetation communities in this area are contained in plots MTNHP plots NHMTECRM05SC0023 and NHMTECRM05SC0024.

Key Environmental Characteristics: This site exists on a precipitation transition zone with sufficient moisture to support rough fescue but with western wheatgrass still occurring; further to the east with little or no decrease in elevation rough fescue drops out rather abruptly (soils are apparently not a factor either). The site is rather uniform in parent material, although slope, aspect and topographic position create soil and moisture differences that result in a variety of tussock grass-dominated grassland communities.

Biological Significance: Within this small area there are quality examples of at least five different Rocky Mountain Front grassland plant communities. This site has been managed to favor the native bunchgrasses, in fact in the year of inventory there had been little use even by early fall (September). The tussocks of rough fescue were among the largest examined in the course of field inventory along the Rocky Mountain Front. Although this condition is not necessarily a management goal, it is unusual in a landscape that is primarily in private ownership and heavily utilized for cattle production. This area may be a good example of the presettlement landscape; these sites are uncommon in this area.

Information Needs: The current site is not precisely delineated. A complete biological

inventory would be helpful. Knowledge of the historic grazing regime would help future managers maintain the existing quality conditions.

Management Needs: The spotted knapweed population currently on the county road and shoulder will invade rodent diggings and other disturbances within the native grasslands if not controlled.

Exotics: A brief survey found the noxious weed spotted knapweed immediately along the county road (not yet spreading into native communities). The only other non-natives encountered were minor populations of common dandelion, yellow (or false) salsify (*Tragopogon dubius*) and herb sophia (*Descurainia sophia*), which was confined to some minor rodent diggings

Bowmans Corners Grassland

Location: This site is accessed by an unimproved county road branching to the east from State Highway 287 about 1.1 north of Bowmans Corners. The area of interest encompasses most of state section 18.

General Description: This area is a gently undulating upland with about 250 ft overall relief (4,100 to 4,360 ft) that encompasses several rocky knobs and ridges. Much of the area is east from a ridge in a long gentle slope to Flat Creek (which is outside the core area). Glacial drift thinly mantles the surface with most of the soils are derived from a fine-textured sandstone. Textures range from fine sandy loams to loams with limited areas of silt and clay loams (with high gravel content). This terrain and soils are typical of the local plains environment. This site, surrounded by rough fescue dominated vegetation, actually is somewhat further from the Rocky Mountain Front than is Augusta, MT, which lies at the same elevation, but has Northern Great Plains vegetation (not rough fescue). Generally, sites further from the Front have more Northern Great Plains vegetation; there is likely a more complex relationship, perhaps including a north to south gradient along the Front.

The most extensive plant community, rough fescue – Idaho fescue, is found on the long, gentle, east-facing backslope with fine sandy loam soils; the combined graminoid cover approaches 80% and the large tussocks (12-20 cm basal diameter) of rough fescue alone constitute about 50% cover. Several other less extensive plant communities occur due with the interaction of soil, slope, and aspect. The finest textured soils also have considerable gravel and are associated with the western wheatgrass – needle-and-thread plant community. Blue grama and prairie sagewort cover are high (>50% and >20%, respectively) in these communities, probably due to the proximity of water and associated grazing pressure. The excellent condition rough fescue community is in the same pasture, but more removed from water. The other communities identified are rough fescue – bluebunch wheatgrass, associated with steep and rocky slopes of all aspects, and rough fescue – western wheatgrass (with a significant component of green needlegrass) on moderate terrain and silt loam soils.

Detailed data and photos of the vegetation communities in this area are contained in MTNHP plots NHMTECRM05SC0174 through NHMTECRM05SC0177.

Key Environmental Characteristics: This area and lands immediately to the south support rough fescue but the prevailing vegetation a short distance to the north and east is dryland agriculture with western wheatgrass in non-crop areas. This is the eastern edge of fescue grasslands in the Front area.

Biological Significance: This landscape has high-quality rough fescue grasslands, mixed with some wheatgrass communities. Most of the surrounding area is either cropped or more heavily utilized grasslands.

Information Needs: The current site is not precisely delineated. A complete biological inventory would be helpful. Knowledge of the historic grazing regime would help future managers maintain the existing conditions. A noxious weed

survey would be helpful, especially considering the degree of disturbance of surrounding terrain.

Management Needs: Management of the fescue grassland based on knowledge of the historic grazing and disturbance regime would help maintain the ecological integrity of this community.

Exotics: An initial brief survey found yellow (or false) salsify (*Tragopogon dubius*) as the only exotic with no noxious plants.

Blackleaf-Muddy Creeks

Location: This area is about 4 miles east of the Rocky Mountain Front escarpment in gentle foothills at the western extremity of the Northern Great Plains. At Bynum on State Route 89, a county road exits the town to the north-northwest and within a few tenths of a miles bends west. This county road runs west for approximately 11.5 miles, then northwest for 1.5 miles and then west for one mile until a prominent junction accesses the Blackleaf Wildlife Management Area. This junction is the central locus of the conservation site.

General Description: This site includes about a 1000 ft (4,580 to 5,575 ft) rise from the westernmost portion of the Northwestern Great Plains into foothills that transition abruptly to the Rocky Mountain Front. There is an abundance of Madison limestone in both the bedrock and the glacial drift soils. These thin and rocky limestone-derived soils favor limber pine and Douglas-fir and perhaps the dwarf-shrubs, creeping juniper, kinnikinnick and shrubby cinquefoil where precipitation is adequate. Rough fescue and Idaho fescue are predominant in lower areas with less precipitation.

The plains to foothills elevation increase has an associated precipitation gradient reflected in the vegetation transition from grassland and dwarf-shrubland to woodlands. The dry extreme of the woodlands are characterized by limber pine, more mesic environments have Douglas-fir, lodgepole pine, and trembling aspen with Douglas-fir-dominated forests on north- and northeast-facing slopes. The limber pine woodlands are fairly

extensive in this site but white pine blister rust has caused extensive mortality in all age classes. This mortality has converted some limber pine patches to a creeping juniper – kinnikinnick / rough fescue plant association. Relatively high canopy cover (up to 60%) of creeping juniper and kinnikinnick with low to moderate cover of rough fescue and Idaho fescue characterize a relatively unique dwarf-shrub plant community that has not been described in the ecological literature (although a similar type where just kinnikinnick is present but less abundant has been described for the eastern portion of Glacier National Park). The most common shrubby cinquefoil communities have rough fescue dominant but more mesic (shrubby cinquefoil / Baltic rush) and even hydric (shrubby cinquefoil / beaked sedge) communities also occur.

Blackleaf, Muddy, and Rinker Creeks drain the area, although only Blackleaf Creek appears to be a perennial stream. Although this is a limestone dominated landscape and assumed to be excessively drained, in some localized areas unique hydrological circumstances produce subirrigated or standing water wetlands. Several bog birch carrs with beaked sedge and/or bluejoint reedgrass undergrowth occur as do very wet trembling aspen – black cottonwood stands with beaked sedge and other sedges. Extensive willow stands with beaked sedge underneath are along the Blackleaf Creek riparian corridor.

More detailed data on wetland vegetation communities in this area are in Lee and Jonkel (1980).

Key Environmental Characteristics: This site is considerably diverse due to a steep precipitation gradient and locally wet hydrology. It lies at the southern extremity of the Front, which has the highest frequency of “Chinook” winds (downslope drying winds) of any place in North America. The high velocity and persistence of prevailing southwesterly winds have flagged the limber pine to varying degrees, especially those on ridges or scattered in a savanna-like structure nearest the plains.

Biological Significance: The unique hydrology here has produced carrs, fens, and other wetland types uncommon in Montana. The wet aspen – cottonwood forests are unusual as are the dwarf-shrubland communities, which occur only along the Front from north of the Sun River drainage into southwestern Alberta. There are also good examples of a wide diversity of forest, woodland, shrubland, dwarf-shrubland and grassland communities representative of the east slope of the Rocky Mountain Front. The high mortality rates in limber pine may affect the grizzly bear population in this documented site of extensive bear use.

Information Needs: The current site is not precisely delineated. A biological inventory, focused on sensitive species and plant communities would be helpful. The carrs, fens and other wetlands are potential habitat for species of concern, e.g. stream orchid (*Epipactis gigantea*). The dwarf-shrublands and the trembling aspen - black cottonwood stands were superficially sampled and could be further characterized. The historic grazing regime is unknown, this knowledge could help explain current conditions and inform future management. Continued noxious weed surveys would be beneficial in maintaining ecological integrity.

Management Needs: Will limber pine decline significantly affect grizzly bear nutrition?

Exotics: An initial brief survey found yellow (or false) salsify (*Tragopogon dubius*) as the only exotic and no noxious plants.

CONCLUSIONS AND RECOMMENDATIONS

We focused on the poorly understood upland grasslands, one of the most ecologically important and threatened ecosystems on the Front, and developed an ecological map of Montana's Rocky Mountain Front. These ecological units represent specific habitats, several of which are either severely threatened (e.g. limber pine) or key habitats (e.g. fescue). We developed detailed descriptions of these habitats in the context of the

National Vegetation Classification hierarchy. Conservation planning is best served when the spatial location of habitats is known and the habitats are ecologically based and described in detail.

Plot data was entered into the MTNHP database and three sites that represented particularly good or unique ecological conditions were also identified and detailed in the database. This database information will be useful for conservation and grazing exclosure planning – more exclosures across all habitat types is essential in understanding the dynamics of these grasslands heavily utilized for grazing. The vegetation map can also be used to model the spread of invasive plant species, which represent an important threat in this area.

While the map and vegetation descriptions can directly aid conservation planning, an associated GIS assessment is recommended to identify key habitat areas that are important for wildlife. Invasive species distribution, road density, water availability, wetland concentration, and other factors key to habitat value can be modeled to identify the most ecologically intact and important areas.

REFERENCES

- DeVelice, R. L., S. V. Cooper, J. T. McGarvey, J. Lichthardt and P. S. Bourgeron. 1995. Plant communities of northeastern Montana: A first approximation. Montana Natural Heritage Program, Helena, MT. 113 pp.
- Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Miscellaneous Publication No. 54. Missoula, MT: University of Montana, School of Forestry, Montana Forest and Conservation Station. 646 pp.
- Huang, C., L. Yang, C. Homer, B. Wylie, J. Vogelmann, and T. DeFelice. 2001. At-satellite reflectance: A first order normalization of Landsat and ETM+ images. USGS White Papers, <http://landcover.usgs.gov/pdf/huang2.pdf>.

- Huang, C., B. Wylie, L. Yang, C. Homer, and G. Zylstra. 2002. Derivation of a Tassled Cap transformation based on Landsat and at-satellite reflectance. *International Journal of Remote Sensing* 23:1741-1748.
- Lawrence, R. L. and A. Wright. 2001. Rule-based classification systems using classification and regression tree (CART) analysis. *Photogrammetric Engineering and Remote Sensing* 67:1137-1142.
- Lawrence, R., A. Bunn, S. Powell, and M. Zambon. 2004. Classification of remotely sensed imagery using stochastic gradient boosting as a refinement of classification tree analysis. *Remote Sensing of Environment* 90:331-336.
- Lee, L. C. and C. J. Jonkel. 1980. The vegetation structure and ecology of grizzly bear habitat in the Pine and Antelope Butte Wetlands, Montana. Unpublished Border Grizzly Project Special Report 36. University of Montana, Missoula. 63 pp.
- Mueggler, W.F. and W.L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. USDA For. Serv., Gen. Tech. Rept. INT-66, Int. For. Range Exp. Sta.
- Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. U.S. Forest Service General Technical Report INT-34. Intermountain Forest and Range Station, Ogden, UT, USA. 175 pp.
- United States Fish and Wildlife Service. 2005. News Release: U.S. Fish and Wildlife Service establishes Rocky Mountain Front Conservation Area. August 10, 2005. USFWS Mountain-Prairie Region, Lakewood, Co.
- Western Regional Climate Center. 2005. Western U.S. Climate Historical Summaries. (<http://www.wrcc.dri.edu/climsum.html>). Desert Research Institute, Reno, Nevada 89512 USA.

APPENDIX A. GLOBAL/STATE RANK DEFINITIONS

HERITAGE PROGRAM RANKS

The international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status. Species are assigned numeric ranks ranging from 1 to 5, reflecting the relative degree to which they are “at-risk”. Rank definitions are given below. A number of factors are considered in assigning ranks — the number, size and distribution of known “occurrences” or populations, population trends (if known), habitat sensitivity, and threat. Factors in a species’ life history that make it especially vulnerable are also considered (e.g., dependence on a specific pollinator).

GLOBAL RANK DEFINITIONS (NatureServe 2003)

- | | |
|------|---|
| G1 | Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction |
| G2 | Imperiled because of rarity and/or other factors making it vulnerable to extinction |
| G3 | Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations |
| G4 | Apparently secure, though it may be quite rare in parts of its range, especially at the periphery |
| G5 | Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery |
| T1-5 | Infraspecific Taxon (trinomial) —The status of infraspecific taxa (subspecies or varieties) are indicated by a “T-rank” following the species’ global rank |

STATE RANK DEFINITIONS

- | | |
|----|---|
| S1 | At high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to extirpation in the state |
| S2 | At risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to extirpation in the state |
| S3 | Potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas |
| S4 | Uncommon but not rare (although it may be rare in parts of its range), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern |
| S5 | Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range |

COMBINATION RANKS

G#G# or S#S# **Range Rank**—A numeric range rank (e.g., G2G3) used to indicate uncertainty about the exact status of a taxon

QUALIFIERS

- | | |
|----|---|
| NR | Not ranked |
| Q | Questionable taxonomy that may reduce conservation priority —Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank |

X	Presumed Extinct —Species believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered
H	Possibly Extinct —Species known from only historical occurrences, but may nevertheless still be extant; further searching needed
U	Unrankable —Species currently unrankable due to lack of information or due to substantially conflicting information about status or trends
HYB	Hybrid —Entity not ranked because it represents an interspecific hybrid and not a species
?	Inexact Numeric Rank —Denotes inexact numeric rank
C	Captive or Cultivated Only —Species at present is extant only in captivity or cultivation, or as a reintroduced population not yet established
A	Accidental —Species is accidental or casual in Montana, in other words, infrequent and outside usual range. Includes species (usually birds or butterflies) recorded once or only a few times at a location. A few of these species may have bred on the one or two occasions they were recorded
Z	Zero Occurrences —Species is present but lacking practical conservation concern in Montana because there are no definable occurrences, although the taxon is native and appears regularly in Montana
P	Potential —Potential that species occurs in Montana but no extant or historic occurrences are accepted
R	Reported —Species reported in Montana but without a basis for either accepting or rejecting the report, or the report not yet reviewed locally. Some of these are very recent discoveries for which the program has not yet received first-hand information; others are old, obscure reports
SYN	Synonym —Species reported as occurring in Montana, but the Montana Natural Heritage Program does not recognize the taxon; therefore the species is not assigned a rank
*	A rank has been assigned and is under review. Contact the Montana Natural Heritage Program for assigned rank
B	Breeding —Rank refers to the breeding population of the species in Montana
N	Nonbreeding —Rank refers to the non-breeding population of the species in Montana

APPENDIX B. KEY TO MAPPING UNITS

Key to Mapping Units

- 1) Lentic water bodies >2 m in depth **WATER**
- 1) Not as above **2**
 - 2) Sparsely vegetated lands (less than 10% canopy cover overall; individual clumps may have much higher cover); includes relatively barren rock exposures or surfaces with soil but unvegetated due to disturbance or harsh environment **3**
 - 2) Not as above **4**
- 3) Montane zone or higher, includes scree, talus or thin soils with sparse vegetation (this condition could include disturbances attributable to past wildfire) **SPARSELY VEGETATED – HIGH ELEVATION**
- 3) Lower elevations; bedrock or other rock/thin soil areas that are sparsely vegetated (<10 % canopy cover for sparse vegetation but occasionally up to 25% cover) **SPARSELY VEGETATED – LOW ELEVATION**
- 4) Upland areas with at least 15% tree canopy cover **5**
- 4) Not as above **6**
- 5) Trembling aspen alone, or in combination with cottonwood species, has 75% relative canopy cover in comparison to the total tree species canopy cover **FORESTED - ASPEN**
- 5) Limber pine strongly dominant, its relative cover at least four times that of the next most abundant conifer species **FORESTED - LIMBER PINE**
- 5) Conifer species other than limber pine dominant **FORESTED - CONIFER**
- 6) Wetland and riparian environments **7**
- 6) Uplands **8**
- 7) Wetlands **NWITYPES**
- 7) Riparian areas dominated by shrubs, trees may be common **SHRUBLAND - RIPARIAN**
- 8) Canopy cover of shrubs and dwarf-shrubs is > or = 10% (do not consider prairie sagewort) **SHRUBLAND - UPLAND**
- 8) Not as above **9**
- 9) Grasslands where rough fescue or Idaho fescue have at least 5% canopy cover **GRASSLANDS – FESCUE (see lead 10 next page to key to Plant Association level)**
- 9) Fescue cover <5%, soil texture fine to medium, western wheatgrass is typically present **GRASSLANDS – FINE -TEXTURED SOILS (see lead 20 next page to key to Plant Association level)**
- 9) Fescue cover <5%, soil texture relatively coarse (sands to sands loams) or rocky and thin soils. Indicator species include needle-and-thread, bluebunch wheatgrass and prairie sandreed **GRASSLANDS - COARSE-TEXTURED SOILS (see lead 24 next page to key to Plant Association level)**

Key to Grassland Vegetation Associations

NOTE: The following Plant Association level keys for grassland types are regionally inclusive, incorporating more plant associations than we documented in the study area. Detailed information on these plant associations can be obtained at www.mtnhp.org or by contacting MTNHP ecologists.

FESCUE GRASSLANDS MAPPING UNIT

- 10) Rough fescue has > or = 5% canopy cover 11
- 10) Rough fescue has < 5% canopy cover 16
- 11) Richardson's needlegrass has > or = 5% canopy cover
..... **Rough Fescue – Richardson's Needlegrass Herbaceous Vegetation**
- 11) Richardson's needlegrass has < 5% canopy cover 12
- 12) Any of the following, considered singly or in combination, have > or = 1% cover: sticky geranium, sticky cinquefoil, tall cinquefoil, slender cinquefoil, Liddon's sedge (*Carex petasata*) and Hood's sedge (*C. hoodii*)
..... **Rough Fescue - Sticky Geranium Herbaceous Vegetation**
- 12) Not as above 13
- 13) Western wheatgrass or streamside (thick-spike) wheatgrass have > or = 5% canopy cover
..... **Rough Fescue – Western Wheatgrass Herbaceous Vegetation**
- 13) Not as above 14
- 14) Bluebunch wheatgrass, needle-and-thread, or blue grama has > or = 5% canopy cover
..... **Rough Fescue – Bluebunch Wheatgrass Herbaceous Vegetation**
- 14) Not as above 15
- 15) Idaho fescue canopy cover > or = 5% **Rough Fescue – Idaho Fescue Herbaceous Vegetation**
- 15) Not as above **Undefined (possibly disturbance impacted) Rough Fescue plant community**
- 16) Richardson's needlegrass has > or = 5% canopy cover or western needlegrass has > or = 10% canopy cover
..... **Idaho Fescue – Richardson's Needlegrass Herbaceous Vegetation**
- 16) Not as above 17
- 17) Any of the following herbs or their combined cover > or = 1% cover: sticky geranium, sticky cinquefoil, tall cinquefoil, slender cinquefoil, Liddon's sedge (*Carex petasata*) and Hood's sedge (*C. hoodii*)
..... **Idaho Fescue - Sticky Geranium Herbaceous Vegetation**
- 17) Not as above 18
- 18) Western wheatgrass or streamside (thick-spike) wheatgrass or their combined cover > or = 5%
..... **Idaho Fescue – Western Wheatgrass Herbaceous Vegetation**
- 18) Not as above 19
- 19) Bluebunch wheatgrass, needle-and-thread, or blue grama has > or = 5% canopy cover
..... **Idaho Fescue – Bluebunch Wheatgrass Herbaceous Vegetation**
- 19) Not as above **Undefined (or disturbance impacted) Idaho Fescue plant community**

FINE- TO MEDIUM-TEXTURED SOILS MAPPING UNIT

- 20) Green needlegrass has > or = 5% canopy cover
..... **Western Wheatgrass – Green Needlegrass Herbaceous Vegetation**
- 20) Not as above 21
- 21) Bluebunch wheatgrass has > or = 5% canopy cover
..... **Bluebunch Wheatgrass – Western Wheatgrass Herbaceous Vegetation**
- 21) Not as above 22

22) Needle-and-thread has > or = 5% canopy cover	Western Wheatgrass – Needle-and-Thread Herbaceous Vegetation
22) Not as above	23
23) Blue grama or needleleaf sedge (<i>Carex duriuscula</i>) or their combined cover > or = 5%	Western Wheatgrass –Blue Grama Herbaceous Vegetation
23) Not as above	Undefined (or disturbance impacted) Western Wheatgrass plant community

COARSE-TEXTURED SOILS MAPPING UNIT

24) Prairie sandreed has > or = 5% canopy cover	Prairie Sandreed – Needle-and-Thread Herbaceous Vegetation
24) Not as above	25
25) Bluebunch wheatgrass has > or = 5% canopy cover	26
25) Not as above	29
26) Needle-and-thread has canopy cover > or = 5%	Bluebunch wheatgrass – Needle-and-Thread Herbaceous Vegetation
26) Not as above	27
27) Blue grama or needleleaf sedge (<i>C. duriuscula</i>) has > or = 5% canopy cover	Needle-and-Thread – Blue Grama Herbaceous Vegetation
27) Not as above	28
28) Sandberg's bluegrass canopy cover > or = 1% and cushion plants not characteristically present	Bluebunch Wheatgrass – Sandberg's Bluegrass Herbaceous Vegetation
28) Not as above	Bluebunch wheatgrass – Cushion Plant Herbaceous Vegetation
29) Needle-and-thread has canopy cover > or = 5%	30
29) Not as above	Undefined (or disturbance impacted) community types characteristic of coarse soils or extreme exposures
30) Blue grama is the short-grass dominant	Needle-and-Thread – Blue Grama Herbaceous Vegetation
30) Not as above	Undefined (possibly disturbance impacted) plant community

APPENDIX C. PLANT ASSOCIATION LIST

Plant Associations known or hypothesized to occur in at least one of the Rocky Mountain Front vegetation mapping units; listed alphabetically within lifeform. Detailed information on these vegetation associations may be found at the NatureServe Explorer website: www.natureserve.org/explorer. Montana specific information is often available at the Montana Natural Heritage Program Community Field Guide website: www.mtnhp.org/Community/guide.asp.

Forest and Woodland Plant Associations and Community Types

Pinus contorta / *Calamagrostis rubescens* Forest (CEGL000139)
Pinus contorta / *Carex geyeri* Forest (CEGL000141)
Pinus contorta / *Linnaea borealis* Forest (CEGL000153)
Pinus contorta / *Shepherdia canadensis* Forest (CEGL000163)
Pinus contorta / *Spiraea betulifolia* Forest (CEGL000164)
Pinus contorta / *Vaccinium cespitosum* Forest (CEGL000168)
Pinus contorta / *Vaccinium scoparium* Forest (CEGL000172)
Pinus contorta / *Arctostaphylos uva-ursi* Forest (CEGL000134)
Pinus flexilis / *Festuca campestris* Woodland (CEGL000806, G3)
Pinus flexilis / *Festuca idahoensis* Woodland (CEGL000805, G5)
Pinus flexilis / *Juniperus communis* Woodland (CEGL000807, G5)
Pinus flexilis / *Pseudoroegneria spicata* Woodland (CEGL000813, G4?)
Pinus flexilis Scree Woodland (CEGL000815, G3Q)
Populus angustifolia / *Cornus sericea* Forest (CEGL00649, G4)
Populus angustifolia Herbaceous Vegetation (Hansen et al. 1995)
Populus angustifolia Recent Alluvial Bar Vegetation (Hansen et al. 1995) (CEMTMTHP25)
Populus balsamifera ssp. *trichocarpa* / *Calamagrostis canadensis* Forest (See International Peace Parks Classification)
Populus balsamifera ssp. *trichocarpa* / *Cornus sericea* Forest (CEGL000672, G3?)
Populus balsamifera ssp. *trichocarpa* Herbaceous Vegetation (Hansen et al. 1995)
Populus balsamifera ssp. *trichocarpa* Recent Alluvial Bar Vegetation (Hansen et al. 1995)
Populus deltoides / *Cornus sericea* Forest (CEGL000657, G3)
Populus deltoides Herbaceous Vegetation (Hansen et al. 1995)
Populus deltoides Recent Alluvial Bar Vegetation (Hansen et al. 1995)
Populus deltoides / *Symphoricarpos occidentalis* Woodland (CEGL000660, G2G3)
Populus tremuloides – *Populus balsamifera* ssp. *trichocarpa* / *Osmorhiza occidentalis* Forest (CEGL000542, G2Q)
Populus tremuloides / *Amelanchier alnifolia* Forest (CEGL000564, G4)
Populus tremuloides / *Calamagrostis canadensis* Forest (CEGL000547, G3)
Populus tremuloides / *Calamagrostis canadensis* Forest (CEGL000574, G3)
Populus tremuloides / *Calamagrostis rubescens* Forest (CEGL000575, G5?)
Populus tremuloides / *Carex geyeri* Forest (CEGL000579, G4)
Populus tremuloides / *Cornus sericea* Forest (CEGL000582, G4)
Populus tremuloides / *Heracleum maximum* Forest (CEGL000595, G3)
Populus tremuloides / *Juniperus communis* Forest (CEGL000587, G4)
Populus tremuloides / *Osmorhiza occidentalis* Forest (CEGL000595, G3?)
Populus tremuloides / *Poa pratensis* Forest (CEGL003148, GNR)
Populus tremuloides / *Prunus virginiana* Forest (CEGL000596, G3G4)
Populus tremuloides / *Spiraea betulifolia* Forest (CEGL000607, G4Q)
Populus tremuloides / *Symphoricarpos albus* Forest (CEGL000609, G3?)
Populus tremuloides Tall Forbs Forest (CEGL000619, G5)
Populus tremuloides / *Urtica dioica* Forest [Provisional] (CEGL005849, G2G3)
Pseudotsuga menziesii / *Arctostaphylos uva-ursi* Forest (CEGL000424, G4)

Pseudotsuga menziesii / *Arctostaphylos uva-ursi* Forest (CEGL000424, G4)
Pseudotsuga menziesii / *Calamagrostis rubescens* Woodland (CEGL000429, G5)
Pseudotsuga menziesii / *Carex geyeri* Forest (CEGL000430, G4?)
Pseudotsuga menziesii / *Carex rossii* Forest (CEGL000431, G2?)
Pseudotsuga menziesii / *Juniperus communis* Forest (CEGL000439, G4)
Pseudotsuga menziesii / *Linnaea borealis* Forest (CEGL000441, G4)
Pseudotsuga menziesii / *Mahonia repens* Forest (CEGL000442, G5)
Pseudotsuga menziesii / *Osmorhiza berteroi* Forest (CEGL000445, G4G5)
Pseudotsuga menziesii / *Spiraea betulifolia* Forest (CEGL000457, G5)
Pseudotsuga menziesii / *Symphoricarpos albus* Forest (CEGL000459, G5)
Pseudotsuga menziesii Scree Woodland (CEGL000911, G5)

Shrubland Plant Associations & Community Types (including tall, medium and dwarf-shrub dominated)

Acer glabrum Avalanche Chute Shrubland (CEGL000172)
Alnus incana Mesic Forbs Shrubland (CEGL001147, G3G4Q)
Alnus incana Mesic Graminoids Shrubland (CEGL001148, G2G3?)
Amelanchier alnifolia / *Pseudoroegneria spicata* Shrubland (CEGL001065)
Artemisia longifolia Sparse Vegetation (CEGL001540, G3)
Atriplex gardneri / *Pascopyrum smithii* Dwarf-shrubland (CEGL1445, G3)
Atriplex gardneri Dwarf-shrubland (CEGL001438, G3G5)
Betula nana / *Carex* spp. Shrubland (CEGL005887, GNR)
Cornus sericea / *Heracleum maximum* Shrubland (CEGL1167, G3)
Cornus sericea Shrubland (CEGL001165, G4Q)
Dasiphora fruticosa ssp. *floribunda* / *Dechampsia caespitosa* Shrubland (CEGL001107, G4)
Dasiphora fruticosa ssp. *floribunda* / *Festuca campestris* Shrub Herbaceous Vegetation (CEGL001503, G4)
Dasiphora fruticosa ssp. *floribunda* / *Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001502, G4)
Elaeagnus commutata Shrubland (CEGL001098, G2Q)
Juniperus horizontalis / *Festuca campestris* Shrub Herbaceous Vegetation (No formal designation)
Juniperus horizontalis / *Festuca idahoensis* Shrub Herbaceous Vegetation (No formal designation)
Rhus trilobata / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001120, G4)
Rosa woodsii Shrubland (CEGL001126, G5)
Salix bebbiana Mesic Graminoids Shrubland (CEGL001174, G3?)
Salix bebbiana Shrubland (CEGL001173, G3?)
Salix boothii Mesic Graminoids Shrubland (CEGL001181, G3?)
Salix drummondiana / *Calamagrostis canadensis* Shrubland (CEGL001191, G2)
Salix drummondiana / *Carex utriculata* Shrubland (CEGL002631, G3)
Salix drummondiana Shrubland (CEGL001190, G3Q)
Salix exigua Temporarily Flooded Shrubland (CEGL001197, G5)
Salix interior Temporarily Flooded Shrubland (CEGL008562, G4G5)
Salix planifolia Shrubland (CEGL001224, G4)
Sarcobatus vermiculatus / *Atriplex gardneri* Shrubland (CEGL001360, G4?)
Sarcobatus vermiculatus / *Distichlis spicata* Shrubland (CEGL001363, G4)
Sarcobatus vermiculatus / *Pascopyrum smithii* - (*Elymus lanceolatus*) Shrub Herbaceous Vegetation (CEGL001508, G4)
Sarcobatus vermiculatus / *Pascopyrum smithii* Shrub Herbaceous Vegetation (CEGL001508, G4)
Symphoricarpos occidentalis Shrubland (CEGL001131, G4G5)

Herbaceous Plant Associations and Communities

Bouteloua gracilis Herbaceous Vegetation (CEGL001760, G4Q)

Calamagrostis canadensis Western Herbaceous Vegetation (CEGL001559, G4Q)
Calamagrostis rubescens Herbaceous Vegetation (CEGL005862, G3G4?)
Calamovilfa longifolia - *Hesperostipa comata* Herbaceous Vegetation (CEGL001473, G3)
Calamovilfa longifolia – *Pseudoroegneria spicata* Herbaceous Vegetation (undescribed)
Carex buxbaumii Herbaceous Vegetation (CEGL001806, G3)
Carex lasiocarpa Herbaceous Vegetation (CEGL001810, G4?)
Carex limosa Herbaceous Vegetation (CEGL001811, G2)
Carex nebrascensis Herbaceous Vegetation (CEGL001813, G4)
Carex nebrascensis Herbaceous Vegetation (CEGL001813, G4)
Carex praegracilis – *Carex aquatilis* Herbaceous Vegetation (CEGL001821, G2G3Q)
Carex simulata Herbaceous Vegetation (CEGL001825, G4)
Eleocharis (montevidensis, palustris, quinqueflora) Seasonally Flooded Herb Vegetation (CEGL003050, G5)
Eleocharis palustris Herbaceous Vegetation (CEGL001833, G5)
Elymus repens Semi-natural Herbaceous Vegetation (CEGL005868, GNA)
Festuca campestris - (*Festuca idahoensis*) - *Achnatherum richardsonii* Herbaceous Vegetation (CEGL005869, G2G3?)
Festuca campestris - *Festuca idahoensis* - *Geranium viscosissimum* Herbaceous Vegetation (CEGL005870, G3?)
Festuca campestris - *Pseudoroegneria spicata* Herbaceous Vegetation (CEGL001629, G4)
Festuca idahoensis - *Koeleria macrantha* Herbaceous Vegetation (CEGL001620, G3Q)
Festuca idahoensis - *Pascopyrum smithii* Herbaceous Vegetation (CEGL001621, G4)
Festuca idahoensis - *Pseudoroegneria spicata* Herbaceous Vegetation (CEGL001624, G4)
Hesperostipa comata – *Bouteloua gracilis* – *Carex filifolia* Herbaceous Vegetation (CEGL002037, G3/G4)
Hesperostipa comata – *Bouteloua gracilis* Herbaceous Vegetation (CEGL001699, G5)
Hordeum jubatum Herbaceous Vegetation (CEGL001798, G4)
Juncus balticus Herbaceous Vegetation (CEGL001838, G5)
Myriophyllum sibiricum Herbaceous Vegetation (CEGL002000, GUQ)
Pascopyrum smithii - *Bouteloua gracilis* - *Carex filifolia* Herbaceous Vegetation (CEGL001579, G4)
Pascopyrum smithii - *Distichlis spicata* Herbaceous Vegetation (CEGL001580, G4)
Pascopyrum smithii - *Eleocharis* spp. Herbaceous Vegetation (CEGL001581, G1)
Pascopyrum smithii - *Hordeum jubatum* Herbaceous Vegetation (CEGL001582, G4)
Pascopyrum smithii - *Nassella viridula* Herbaceous Vegetation (CEGL001583, G3G4)
Pascopyrum smithii Herbaceous Vegetation (CEGL001577, G3G5Q)
Poa pratensis - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation (CEGL005265, GNA)
Pseudoroegneria spicata – *Bouteloua gracilis* Herbaceous Vegetation (CEGL001664, G4)
Pseudoroegneria spicata – *Hesperostipa comata* Herbaceous Vegetation (CEGL001679, G4)
Pseudoroegneria spicata - *Pascopyrum smithii* Herbaceous Vegetation (CEGL001675, G4)
Pseudoroegneria spicata – *Poa secunda* Herbaceous Vegetation (CEGL001677, G4?)
Sarcobatus vermiculatus / *Leymus cinereus* Shrubland (CEGL001366, G3)
Schoenoplectus acutus Herbaceous Vegetation (CEGL001840, G5)
Schoenoplectus americanus Western Herbaceous Vegetation (CEGL001841, G3Q)
Schoenoplectus maritimus - *Schoenoplectus acutus* - (*Triglochin maritima*) Herbaceous Vegetation (CEGL002227)
Schoenoplectus maritimus Herbaceous Vegetation (CEGL001843, G4)
Typha (latifolia, angustifolia) Western Herbaceous Vegetation (CEGL002010, G5)
Typha latifolia Western Herbaceous Vegetation (CEGL002010, G5)

*Where types are not yet recognized by NatureServe, a reference has been provided. Some types are tentative, not formally described elsewhere.